# TERRESTRIAL VERTEBRATES MONITORING HANDBOOK

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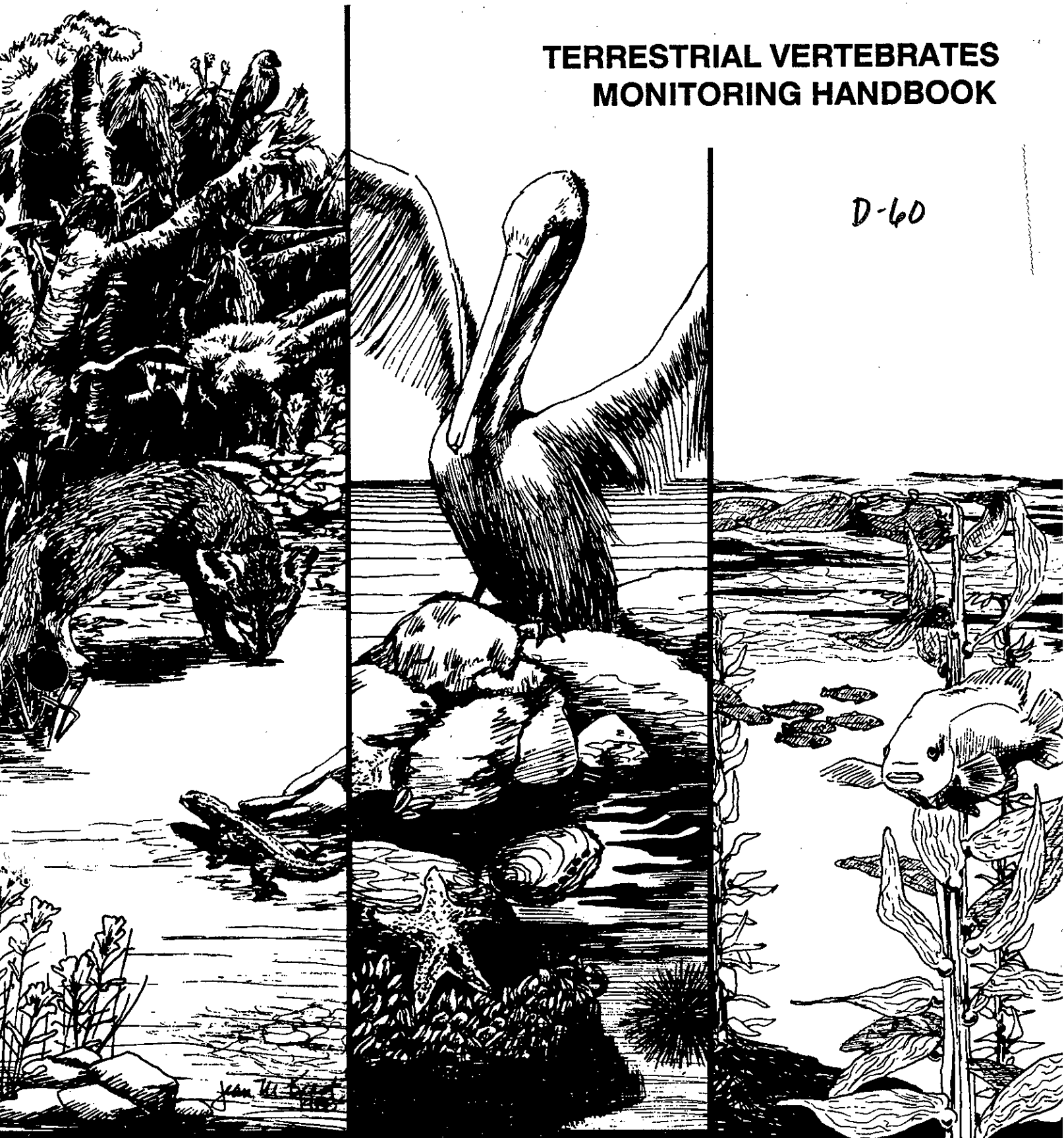

# Channel Islands National Park

National Park Service
U.S. Department of the Interior

# TERRESTRIAL VERTEBRATES MONITORING HANDBOOK

## CHANNEL ISLANDS NATIONAL PARK CALIFORNIA

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## ACKNOWLEDGEMENT

The superintendent and park staff have provided both moral and logistical support during the development of this monitoring program. The island rangers and boat captains have been particularly helpful, frequently going out of their way to accommodate and assist us. Frank Ugolini has provided invaluable support, making logistical arrangements and relaying communication on innumerable occasions as well as offering constant encouragement. Karen Johnston has handled scheduling and communications (frequently both long-distance and on short notice) in a manner that is not only professional and efficient, but also shows a real concern for all the people involved. Working on the island for long periods of time presents special difficulties and hardships. Without the support of those mentioned here, and many others, this work would not have been possible.

The final quality of the handbook has been improved by the review and editorial comments of Ronilee Clark and Joan Fellers.

# INTRODUCTION

This handbook outlines monitoring techniques for the seven species of native amphibians, reptiles, and terrestrial mammals on Anacapa, Santa Barbara, and San Miguel islands.

The Pacific slender salamander (*Batrachoseps pacificus pacificus*), southern alligator lizard (*Gerrhonotus multicarinatus*), western fence lizard (*Sceloporus occidentalis becki*), side-blotched lizard (*Uta stansburiana*), and island night lizard (*Xantusia riversiana*) are monitored on all the islands where they occur.

| Species | AI | SBI | SMI |
|---|---|---|---|
| Pacific Slender Salamander (*Batrachoseps pacificus*) | X | - | X |
| Western Fence Lizard (*Sceloporus occidentalis*) | - | - | X[1] |
| Side-blotched Lizard (*Uta stansburiana*) | X[1] | - | - |
| Southern Alligator Lizard (*Gerrhonotus multicarinatus*) | X | - | X |
| Island Night Lizard (*Xantusia riversiana*) | - | X | - |
| Deer Mouse (*Peromyscus maniculatus*) | X | X | X |
| Island Fox (*Urocyon littoralis*) | - | - | X |

[1]Western fence lizards and side-blotched lizards are not readily captured by the established monitoring methods and the amount of data collected will probably not allow for detailed analysis.

**Table 1. Native Terrestrial Vertebrates on Anacapa, Santa Barbara and San Miguel Islands.**

The island night lizard is of particular interest because it is federally-listed as a threatened species and is fully protected by the state. The island night lizard and the subspecies of the Pacific slender salamander and western fence lizard are endemic to the Channel Islands.

The amphibian and reptile monitoring program provides two measures of population status, an uncalibrated index of population size and a weight-length regression. The population index allows the park to track changes in population size and thus detect both long-term trends and sudden, short-term changes. The weight-length regression provides a measure of the general health of the population. While not a primary goal of the monitoring, it is also possible to document significant changes in distribution for any of the species.

Deer mice (*Peromyscus maniculatus anacapae, P. m. elusus*, and *P. m. streatori*) and island foxes (*Urocyon littoralis littoralis*) are sufficiently important in the Channel Islands ecosystems that they warrant close attention as part of the monitoring program. The deer mice are dominant components of island communities. As abundant generalist granivores/predators, they undoubtedly have significant influence on the plants and terrestrial invertebrates on the islands. As prey species, they largely determine the numbers of some of the resident hawks and owls. Similarly, the island foxes are relatively abundant generalist predators which probably affect a variety of other species on San Miguel Island. They are of particular interest to the park both because they are an endemic species to the Channel Islands and because they are listed by the state as a threatened species. Also, both the foxes and deer mice have differentiated to the subspecific level on each island where they are found. For these reasons, the most accurate means of monitoring deer mice and island foxes has been implemented.

# MONITORING DESIGN CONSIDERATIONS

Amphibians and reptiles are monitored by using artificial cover (12 in. x 12 in. x 2 in. boards) that has been placed on all three islands. As part of the design portion of the study, 3/8 in. plywood and both 2 in. and 4 in. thick boards were tested for use as cover. The plywood worked fairly well, especially in the cooler parts of year. Two inch thick wood,

however, proved to be much superior in its ability to retain moisture and to provide a more stable temperature environment, especially during the spring and summer. The four inch wood was also superior to plywood, but was no better than 2 inch wood. Hence, all the plywood has been replaced with 2 inch pieces of fir and it is recommended that 2 inch wood be used for all monitoring.

Pitfall traps consisting of gallon plastic jars sunk level with the ground and covered with plywood lids, were also tested for use in the monitoring program. Pitfall traps worked well for capturing lizards, but they required much more time to maintain and operate than did the boards. Also, salamanders which fell into pitfall traps often died.

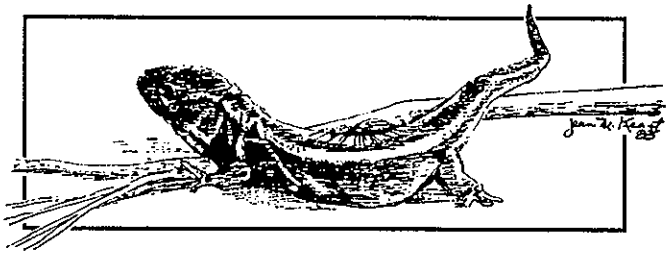
Side-blotched lizards and western fence lizards will probably not be caught in sufficient numbers to allow for detailed data analysis. This low capture rate is due to the combination of their restricted distribution, relatively low population size and low susceptibility to the sampling techniques. While these two species can be caught fairly readily using pitfall traps, the benefits do not outweigh the amount of time required to maintain and operate traps nor the amount of salamander mortality that would occur. Though it is not anticipated that data on relative abundance will be obtained for these two lizards, it should be possible to document changes in their distribution if they occur.

The monitoring program for mice and foxes involves the use of trap grids. Previous researchers have traditionally used transects (or trap lines) for capturing mice and foxes. Transects can provide a relative index of population size, but since the area trapped is not reliably known, the technique does not allow a reliable estimation of population size (White et al. 1982). Other techniques for monitoring foxes (e.g. scat counts, hair snares, scent stations, dropping boards, runway counts) are useful mostly for determining the presence of species in an area. These techniques are appropriate for baseline surveys where the occurrence or distribution of a particular species may not be known, but the techniques provide limited information on trends in population size. Hence grid trapping is the only appropriate procedure for monitoring these species on the Channel Islands. The spacing between traps has been selected based on 1) past research which has provided a standard for comparison (e.g. 0.2 mi spacing for fox traps) and 2) considerations of home range movements. In general, the spacing should be such that at least four traps are located in an area the size of the expected home range of the animal being studied (White et al. 1982).

Deer mice are trapped for three consecutive nights using 10 x 10 grids of 100 Sherman live traps. Twelve such grids have been established on the three islands and an additional grid will be established on East Anacapa Island. Island foxes are trapped for eight consecutive nights using 25 live traps arranged in a 5 x 5 grid. Five such grids have been established on San Miguel Island. Trapping data are used to calculate population size and data on weight, age, sex, and reproductive condition are used to evaluate the general health of the population.

The locations of board transects and trapping grids were selected to represent the range of both habitats and geographic diversity on each island. For an example, amphibians and reptiles are not sampled in the stabilized dune on San Miguel Island because no amphibians or reptiles were captured there during the design phase of the research.

# MONITORING PROTOCOL



## AMPHIBIANS and REPTILES

### Methods

Table 1 shows the species present on each island. Of these, the side-blotched lizard on Anacapa and the western fence lizard on San Miguel Island are only marginally susceptible to capture by the methods described here. Data should be collected on these species as far as possible, but the monitoring program will only yield extensive data on Pacific slender salamanders, alligator lizards, and island night lizards. Table 2 on the following page summarizes the schedule of counts for each transect.

| Transect | Habitat | Month | Frequency |
|---|---|---|---|
| **East Anacapa Island** | | | |
| Inspiration Point | *Coreopsis*/Ice Plant | Dec, Jan, Apr | Yearly |
| Lighthouse Point | Grassland | Dec, Jan, Apr | Yearly |
| **Middle Anacapa Island** | | | |
| Grassland | Grassland | Dec, Jan, Apr | Yearly |
| Sagebrush | Sagebrush | Dec, Jan, Apr | Yearly |
| **West Anacapa Island** | | | |
| West Anacapa Island | Grassland | Dec, Jan, Apr | Yearly |
| **Santa Barbara Island** | | | |
| Cave-Middle | Boxthorn | Apr, May, June | Yearly |
| Middle Canyon | Prickly Pear | Apr, May, June | Yearly |
| Middle-Graveyard | Boxthorn | Apr, May, June | Yearly |
| Terrace Grassland | Grassland | Apr, May, June | Yearly |
| Webster Point | *Suaeda* | Apr, May, June | Yearly |
| **San Miguel Island** | | | |
| Air Strip | *Haplopappus* | Dec, Jan, Apr | Yearly |
| Green Mountain | Grass | Dec, Jan, Apr | Yearly |
| Nidever | Lupine | Dec, Jan, Apr | Yearly |
| San Miguel Hill | Rock | Dec, Jan, Apr | Yearly |
| Willow Canyon | Grassland | Dec, Jan, Apr | Yearly |

**Table 2. Amphibian and Reptile Monitoring Schedule.**

Figures 1- 6 in Appendix B show the location of each of the above transects. These transects generally consist of 60 boards arranged in two rows of 30. The rows are approximately 5 m apart and the spacing between boards in each row is approximately 5 m. The end board in each row is marked with a metal tag with the board number (e.g. 1, 30, 31 or 60). The other boards are not numbered. The boards are 12 in. x 12 in. x 2 in. pieces of pine or fir. Deviations from the standard arrangement of boards are discussed for specific transects in Appendix B.

Transects are checked by quickly lifting each board and capturing the amphibians and reptiles underneath. For transects checked in the winter months, it should be relatively easy to capture both the lizards and salamanders. Transects which are checked in the warmer spring months will prove more difficult since the lizards are more likely to be warm and active. It is best to check transects in the early morning before the lizards warm up. Note that in spite of the name, island night lizard, these lizards are decidedly diurnal and hence most likely to be cool and inactive early in the day.

If an animal escapes, the body length (not including the tail) should be estimated to the nearest centimeter. Estimated lengths are recorded in the comment field, not in the usual space for length since estimated lengths cannot be used in any statistical calculations. On the other hand, it is important to record all salamanders and lizards found since they will be used in the population index calculations.

Record the board number, species, body length, weight, and comments on the data forms shown in Appendix D-1. Body length is measured from the tip of the snout to the opening of the vent. This is best viewed from the side as the lizard or salamander is held against a wooden or metal ruler with a "stop" at one end. The procedure is to hold the tip of the snout against the stop and gently align the body along the ruler. Try to get the animal's head, neck,

and body in a straight line without causing it to "tense up." You should aim to have the animal straight and relaxed. There is a bit of flexibility in the vertebral column so it is important that you do not straighten the animal by pulling hard on its body since this stretches the animal and, while this does not cause any harm, leads to an inaccurate measurement.

Salamanders and lizards are put in plastic sandwich bags for weighing. After the animal is in the bag, fold the bag over two or three times. This reduces the space in which the animal can move and also decreases the surface for the wind to blow against. The bag is then clipped to a spring scale and weighed. On windy days it is helpful to use a plastic one-gallon jar. The bag can be suspended in the jar which will greatly reduce the effect of the wind. Make sure that the bag does not touch the sides of the jar.

Salamanders will dry out rapidly during handing, especially if they struggle during measurement. Carry a bit of water along to moisten animals during or after handling. When an animal seems to be drying out, hold the salamander in your hand and pour 5-10 ml of water over it. Cupping your hand will hold the water for a minute or so and give the salamander a better chance to absorb water.

After checking under a board, it must be carefully replaced. The board should lie directly on the ground and not be held up by vegetation or small rocks. Once the board is in place, release salamanders and lizards at the edge of the board. This procedure is particularly important for salamanders that must have both the protection and moisture available under the boards.

Upon completion of a trapping session, the Daily Trapping Summary form (Appendix D-4) is used to record the transects checked and the number of amphibians and reptiles captured each day.

## Equipment Needed

Pen with waterproof ink and clipboard
Plastic sandwich bag for weighing
Wooden or metal 30 cm ruler
10 and 50 gram Pesola scale
Water to moisten salamanders
Data forms

Optional:
- Walking stick or pole for locating boards
- One-gallon plastic jar -
  - used on windy days to help weigh animals
- Vials with 70% alcohol for parasites
- Compass

## Special Considerations

The island night lizard is a federally-listed species. If the park intends to capture this lizard as part of the monitoring program, it will be necessary either to:

- petition the Office of Endangered Species, Fish and Wildlife Service to request a permit or

- develop a cooperative agreement with the California Department of Fish and Game to work under their umbrella agreement with the Fish and Wildlife Service.

Experience has shown that the first alternative requires more administrative procedures, but is generally more satisfactory.

When capturing lizards, especially night lizards, it is important to avoid grabbing the tail. With the exception of the southern alligator lizard, all of the lizards lose their tails quite readily. Loss of a tail may have a significant effect on survivorship, reproduction, and dominance interactions with conspecifics.

Salamanders can be censused only when the ground under the cover boards is sufficiently moist. While it is not possible to give exact guidelines, it would be best if one or two winter storms occur just prior to checking the boards. If there has been little or no rain and the ground is essentially dry, the surveys will not adequately sample salamanders. Data collected when conditions are not suitable for salamanders should not be used in analyzing trends in salamander population levels.

Since vegetation can grow over boards and obscure them, it is useful to carry a walking stick or pole to tap the ground in the vicinity of any board that is not obvious. This technique is much more efficient than searching through the vegetation by hand.

Boards occasionally crack and break apart with age and it is strongly recommended that such boards be replaced immediately. A broken board does not provide nearly as good shelter and hence the data are not comparable. Therefore, two to three extra boards should be carried when checking transects. Also, in some areas such as the grasslands on San Miguel Island, the ground cracks and forms a depression under boards after a few years. When this happens, the boards should be moved a foot or two so that the ground underneath is more uniform.

Species identification should not be a problem most of the time. On Anacapa and San Miguel Islands, young alligator lizards may be confused with the other lizards by an inexperienced observer. Alligator lizards have a distinctive fold of skin along the side of their body which separates the dorsal and ventral scales. This fold is not present in other lizards on the islands. Also, alligator lizards have large scales on both the dorsal and ventral sides unlike the other lizards on the islands. For additional identification information see Stebbins (1985).

## Data Input

Data for each transect are entered into a computer data base using the HERP.PRG program that runs from within dBase III and uses the HERP.DBF file to store data. Begin the program at the dot prompt by typing:

**DO HERP**

The program prompts the user for information in the same order as on the data form. Estimated lengths should be noted in the comment field, but not be used in the weight- length regression.

Island abbreviations are as follows:

| | | |
|---|---|---|
| AI | = | Anacapa Island |
| SB | = | Santa Barbara Island |
| SM | = | San Miguel Island |

Abbreviations for the amphibians and reptiles are:

| | | |
|---|---|---|
| BP | = | *Batrachoseps pacificus* |
| GM | = | *Gerrhonotus multicarinatus* |
| SO | = | *Sceloporus occidentalis* |
| US | = | *Uta stansburiana* |
| XR | = | *Xantusia riversiana* |

The HERP.PRG program will not allow a combination of island and species that is not correct.

After entering all of the data, it is essential to print and proofread these data prior to analysis. The HERP.DBF file can be edited using the dBase edit or browse commands.

## Data Analysis

### Population Index

A population index is calculated for each species for each transect. At the end of the field season, calculate the index by combining the data for the three sampling periods and calculating the capture rate (animals/board) for each species along the transect.

In order to visualize trends, graph the data as capture rate (showing one standard error) versus year for each species. Plot each transect for each species separately. Graph and analyze the data for alligator lizards and slender salamanders separately for islands where they occur. This analysis will provide information on annual changes in abundance.

Short-term changes in population indices can be examined by comparing the current with the previous year's population index using a Chi-square contingency analysis. For example, arrange the island night lizard data in a 2 x 5 table reflecting the two years to be tested and the five transects present on the island.

Long-term trends are analyzed using autoregressive time series analysis (Edwards and Coull 1987). This technique is appropriate for detecting trends in autocorrelated time series data such as will be collected as part of the monitoring program.

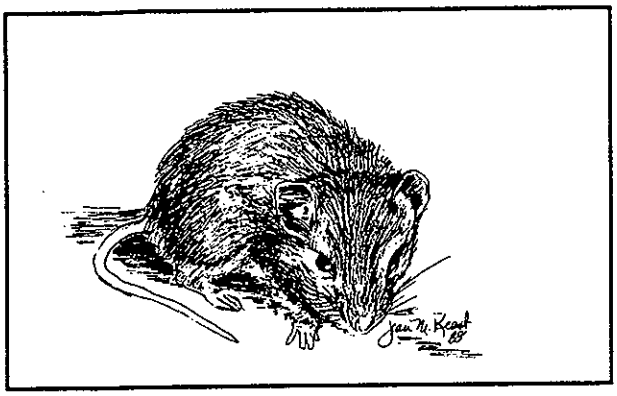
### Weight-Length Regression

The relative mass of an animal can provide an indication of its health, e.g. healthier animals are likely to weigh more. Since weight has a curvilinear relationship with body length, it is necessary to calculate a regression as weight versus length$^3$. Differences in slope can then be evaluated statistically (Zar 1974). The current year should be compared with the slope for the previous year. Significant differences in slope would indicate a change in the overall health of the population.

## Interpretation of Data

Several patterns should be looked for in the data. The first is year to year fluctuation in the indices of abundance. Normal year-to-year changes may be relatively great for some species. It is anticipated that data will need to be collected for at least five years before the magnitude of these natural fluctuations can be documented. Until then, the significance of observed changes will not be certain. Data for Pacific slender salamanders may prove difficult to interpret since their activity will be strongly moderated by rainfall. Hence changes in population indices must be interpreted in light of recent weather patterns. As noted earlier, data collected when conditions are not suitable for salamanders should not be used in analyzing trends in salamander population levels.

The monitoring program will also detect changes in distribution. Distributional changes would be expected on islands where there are shifts in the vegetation. Significant changes in the vegetation on Santa Barbara Island have been noted since the removal of rabbits in 1981. If these changes continue, there should be concomitant shifts in the distribution of night lizards. Fires could also initiate a similar process. Hence the transect data will provide a baseline for documenting changes in both the abundance and distribution of amphibians and reptiles on all three islands.



# DEER MICE

## Methods

Monitoring of deer mice employs mark-recapture grids. There are currently two grids on Anacapa, three on Santa Barbara and seven on San Miguel. The park will establish an additional mouse grid on East Anacapa Island to document the natural reestablishment of deer mice as rats are removed. Figures 1- 6 in Appendix B show the location of each of these 13 grids.

The mouse grids consist of 10 rows of 10 traps spaced 7 m apart. Hence the entire grid measures 63 m on each side. Each trap site is marked with a wooden stake with the site number written on it. The corner stakes also have metal tags with the number in case the original numbers fade. Trap sites are recorded as a two number sequence representing row and column. Hence the first row of the grid is marked as 1,1 through 1,10 and the last row is 10,1 through 10,10. This numbering system has been used to facilitate data analysis by the CAPTURE program which calculates population size.

Traps should be set in the late afternoon. In the more open habitats, it is easiest to make two passes through the grid, first to drop a trap at each station and second to bait the traps. Each trap must be placed as close as possible to the grid stake and situated firmly on the ground. The trap can be oriented in any direction, but it must open into a relatively clear area that a mouse could use as a runway. Be sure that the entrance is not blocked by dense grass or shrubs. The traps should not be oriented such that the wind might blow the bait or cause the trap to shut.

| Grid | Habitat | Month | Frequency |
|---|---|---|---|
| **Anacapa Island** | | | |
| East Anacapa Island[1] | Grassland | August | Even years |
| Anacapa Island | Grassland | Mar & Aug | Yearly |
| West Anacapa Island | Grassland | Mar & Aug | Yearly |
| **Santa Barbara Island** | | | |
| Terrace Grassland | Grassland | Mar & Aug | Yearly |
| Terrace *Coreopsis* | *Coreopsis* | Mar & Aug | Yearly |
| Webster Point | *Suaeda* | Mar & Aug | Yearly |
| **San Miguel Island** | | | |
| Air Strip | *Haplopappus* | Apr & Sept | Yearly |
| Green Mountain | Grassland | Apr & Sept | Yearly |
| Harris Point | Stable Dune | Apr & Sept | Odd years |
| Nidever | Lupine | Apr & Sept | Yearly |
| Point Bennett | Stable Dune | Apr & Sept | Even years |
| San Miguel Hill | Rock | Apr & Sept | Even years |
| Willow Canyon | Grassland | Apr & Sept | Yearly |

[1] Because of the success of the rat control program on East Anacapa Island, the park will establish a grid here and begin monitoring mice so that the natural reestablishment of deer mice can be documented.

**Table 3. Deer Mouse Monitoring Schedule.**

Occasionally it may not be possible to locate a stake either because it is missing or because of dense vegetation. In such a case, pace off the distance from at least two of the adjacent stakes and place the trap in the appropriate position. A few extra stakes should be available to replace ones that are missing.

Each trap must be checked every day to make sure the trigger is set correctly. This is done by setting the trap and then pushing in on the rear door until the treadle is depressed slightly. If the trigger is set properly, the trap door will snap closed. If the door will not stay open or if depressing the treadle does not set off the trap, the trigger must be adjusted by bending it slightly forward or backwards. Such adjustments are usually very slight and can be accomplished with only a light push on the trigger.

Traps are baited with rolled oats. The "old fashion" variety is better than the "instant" since the latter tends to get wet and gummy with even a small amount of moisture. Each trap should be baited with about a teaspoon of oats. Use a bit more or less depending on how much bait is left in traps which catch mice. Most of the bait should be placed on the treadle in the back of the trap. Be careful not to get bait under the treadle such that the trap cannot be set off. A few oats scattered on the front door of the trap and at the entrance may be helpful in attracting mice. Do not, however, get too much bait outside the trap or the mice will eat their fill outside and not go in.

Traps should be opened and baited in the late afternoon and left closed during the day, otherwise mice might enter the trap during the day and die from overheating. On the last day, any remaining oats should be shaken out of the trap and traps with significant fecal material or wet oats should be set aside for cleaning.

When checking the traps in the morning, be exceedingly careful not to let any mice escape. Mice that escape without being marked or having their tag read can significantly bias the data analysis. The initial handling of mice is partly a matter of personal preference, but the method outlined below works well. It helps to wear a cotton glove on the left hand (vice versa for left-handed people) to reduce the chance of getting bitten. With small Sherman traps, it is best to place the mouth of the trap over a plastic jar or bag, open the door with one finger and shake the mouse out. The mouse can then be caught with the gloved hand. With large Sherman traps, the gloved hand is used to cover the opening of the trap as you reach in with the other hand to grab the mouse by the tail. As soon as you have the mouse out, grab it at the base of the tail with the gloved hand and hold the mouse so it is sitting in the palm of your hand.

Always read and record the tag number immediately. If the mouse is not tagged, proceed with the tagging first. Place a tag in the pliers and insert the tag in the cartilaginous portion of the ear just behind the external ear opening. Avoid applying the tag out toward the edge of the pinna where it is more likely to tear out. Once the tag is in place, confirm the tag number and write it down. Use the forms shown in Appendix D-2 to record data.

Finish processing the mouse by noting weight, sex, age, and (for females) whether or not the nipples are enlarged.

A shorthand method of recording mouse data has proven to be quick, accurate and efficient. First the trap, then tag numbers are recorded. This is followed by the age of the mouse noted as J, S, or A which stands for juvenile, subadult, or adult. The sex is noted with either a lower case f or m (female or male). Brief notes can be indicated with a circled footnote number which is explained at the bottom of the page. For example, 1 = nipples enlarged; 2 = ear torn, probably lost tag.

The Daily Summary form (Appendix D-4) is used to record the grid being trapped, the number of trap nights and the number of mice captured each day.

## Age

Most of the mice will be adult or subadult. Juvenile mice will be conspicuous because of their very small size (less than 12 g) and their uniform, dove-gray pelage which has no black hairs peppered with the gray. The underparts of a juvenile are also gray, in contrast to older mice which have dull white undersides.

Subadults have dull gray upperparts peppered with black hairs. There are no brown or reddish-brown

hairs mixed in with the gray. The underparts are white.

Adults are characterized by brown or reddish-brown hairs mixed in with the gray upperparts. The underparts are white.

Mice are frequently caught when molting from subadult to adult pelage. The subadult to adult molt can occur in mice as small as 14-16 g. In these mice, there will be:

1. two conspicuous patches of reddish-brown fur on the flanks,
2. a saddle of adult fur across the back, or
3. extensive adult pelage except for the head.

Record these mice as subadult and note that they are molting.

## Sex

Even very young mice can be sexed relatively easily. The penis of the male is larger and placed farther forward than the clitoris of the female. This is the most conspicuous difference between sexes. Alternatively, check for the vaginal opening located immediately posterior to the clitoris or the presence of an obvious scrotum.

## Weight

Mice are weighed by clipping the scale to the base of the tail. On windy days, it helps to carry a plastic one-gallon jar. The mouse can be suspended in the jar to get a more accurate weight. Make sure that the mouse does not touch the sides of the jar.

## Reproductive Condition

Check to see if the nipples of subadult or adult females are enlarged. Mice that have not had young have nipples which are barely noticeable bumps. Lactating females have nipples which are large and somewhat puffy. When lactation is completed, the nipples are somewhat constricted and dry, but noticeably larger than non-breeding females.

## Equipment Needed

Pen with waterproof ink and clipboard
Sherman live traps
Rolled oats ("old fashion" variety)
Data form
Ear tags (#1)
Ear tag pliers (1#)
50 gram Pesola scale
Grease pen to mark traps moved to shade

Optional:
Cotton gloves
One-gallon plastic jar -
used on windy days to help weigh mice
Vials with 70% alcohol for parasites
Compass

Lab Equipment:
Spare trap doors

## Special Considerations

Both the small and large Sherman traps have been used to trap mice. There have been no problems with either size trap on Anacapa and San Miguel Islands, but on Santa Barbara Island, island night lizards are sometimes caught in Sherman traps. The small Sherman traps often damage the tail of island night lizards and hence it is essential that only large Sherman traps be used on Santa Barbara Island.

Sherman traps provide only moderate shelter from rain. Hence it is important to check traps early in the day and to consider the possibility of rain when setting traps. Trapping should not be conducted when more than a light rain is expected. If it does rain, check traps earlier in the day. Once a mouse gets wet, its fur loses most of its insulation value and the mouse is likely to die from exposure. If mice do get wet, it is appropriate to release all of the mice on the grid immediately rather than continuing with the normal processing. This is especially true for the first two days of trapping when the loss of animals is likely to invalidate the population estimate.

On warm, clear days traps can easily overheat and act like small ovens in the sun. It is important to begin checking traps at sunrise - as soon as there is enough light to work. When trapping success is high, even an early start is not enough. As traps warm to the touch, you should stop processing

mice and go through the rest of the grid to locate traps with mice. The grid coordinates should be written on the trap with a grease pencil and the trap moved to nearby shade. If no other shade is available, stand the trap on end and lean it on the shady side of the stake. Once all the traps are protected, you can finish processing mice. Remember to release each mouse at its original stake. Failure to take these kinds of precautions is not only inhumane, it is likely to invalidate the population estimates for that trapping session.

Mice tend to gnaw on the Sherman trap doors. After several trapping sessions, some doors have sufficiently large holes that mice can escape. Such traps should be replaced or repaired. It is also a good idea to carry a couple of spare traps during each trapping session to substitute for damaged traps.

## Data Input

Data for each grid are entered into a computer data base using the MOUSE.PRG program which runs from within dBase III and uses the MOUSE.DBF for the file structure. Make sure that both the Mouse programs are in the default subdirectory. After starting dBase, begin the program by typing:

**DO MOUSE**

The program prompts the user for the name of the dBase data file to use. It is easiest to store and analyze data if they are stored in a separate file for each trapping session for each grid. Hence, if you are entering August, 1989 data for the Webster Point grid, you might name the file WP_AUG89.DBF. If the file does not already exist, a new file is created based on the structure of the MOUSE.DBF file (which needs to be present in the same subdirectory). If the file already exists, it is opened and you can add more data. Once the file has been loaded, the program prompts the user for information as displayed on the data form. Follow the menus to enter all of the data.

The abbreviations for the islands are as follows:

AI = Anacapa Island
SB = Santa Barbara Island
SM = San Miguel Island

The appropriate abbreviations for the mouse grids are as follows:

**Anacapa Island**
EA = East Anacapa
MA = Middle Anacapa
WA = West Anacapa

**Santa Barbara Island**
TC = Terrace *Coreopsis*
TG = Terrace Grassland
WP = Webster Point

**San Miguel Island**
AS = Air Strip
GM = Green Mountain
NI = Nidever
HP = Harris Point
PB = Point Bennett
SM = San Miguel Hill
WC = Willow Canyon

Combinations of islands and grids that are not appropriate are not allowed by the MOUSE.PRG program.

After entering all of the data, it is essential to print and proofread these data prior to analysis. The data file can be edited using the dBase edit or browse commands.

## Data Analysis

### Population Size

Population size is calculated using the CAPTURE.EXE program. There are two steps to running the CAPTURE program.

1. Convert the dBase file to the proper format for analysis.

2. Run the CAPTURE program.

Two programs have been written to automate these steps. The input file for CAPTURE is created using the dBase program MOUSE_C.PRG. To run it, start dBase and type:

**DO MOUSE_C**

The MOUSE_C.PRG program asks for the name of the data file and then proceeds with the data conversion. Messages on the screen keep you posted as to the status of the conversion. The file created by MOUSE_C has the same name as the original file, but the extension is SDF. Thus if the data file is WP_AUG89.DBF, the temporary file would be WP_AUG89.SDF.

The second step is carried out at the DOS prompt. A batch file CALC.BAT has been provided to run CAPTURE. The data file must have the extension SDF and the output file will have the same name as the input file and an OUT extension. To run CALC, make sure that the data file and the CAPTURE program are in the same subdirectory of a hard disk and then type CALC and the filename with no extension. Hence if the data file is WP_AUG89.SDF, you would enter:

**CALC WP_AUG89**

After about a minute, the screen should return the message "Capture Successful Execution" and a note about the output file. The output file in this example would be called WP_AUG89.OUT. This file must be printed on a wide-carriage (132 character) printer. A complete discussion on reading the output file and statistical interpretation is provided in Appendix I.

Plot the data for each grid over time as a line graph. CAPTURE includes a standard error for the population estimate in its output file. This should be included on the graph.

Short-term changes in population indices can be examined by comparing the current with the previous year's population index using a t-test. Long-term trends are analyzed using autoregressive time series analysis (Edwards and Coull 1987). This technique is appropriate for detecting trends in autocorrelated time series data such as will be collected as part of the monitoring program.

### Age, Sex, Weight, and Reproductive Condition

Data on sex, age, weight and reproductive condition can be useful in interpreting trends in population dynamics. These data do not need to be analyzed statistically, but they should be summarized and graphed for each trapping session as follows:

1. Age data are tabulated as both the total number and the percent of each of the three age classes. The percentage of each age class may then be plotted for each trapping session.

2. Sex data are tabulated as the number of males, number of females and the male:female ratio for each trapping session. These data are then plotted as proportion of males versus time.

3. Reproductive condition is tabulated as both the number and percent of females lactating. Data are then plotted as percent lactating versus time.

4. Calculate average weight for adult males, adult females, subadult males, and subadult females. Plot these data as average weight for each of the four groups (e.g. adult males) versus time. A separate graph is prepared for each grid.

Statistical analysis of the above data would be useful if the population data indicate a significant trend. Otherwise, the importance of collecting these data is in establishing a baseline for future comparisons. Note that the statistical analysis of these data is complicated by the fact that the data are not independent. Many of the mice will be the same from one session to the next.

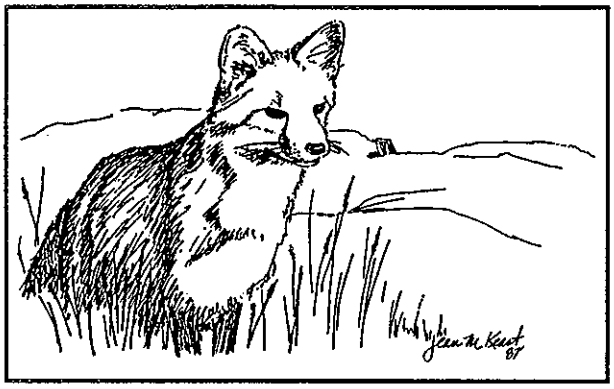
## Interpretation of Data

Mouse trapping has been conducted on Santa Barbara Island for 7 years and additional data are available spanning a 10-year period. One of the most significant findings is that there are large fluctuations in population levels that are related to annual rainfall, predation pressure, and season. Total captures have ranged from a low of 1-2 mice/300 trap nights up to 150 mice/300 trap nights. Estimated densities have ranged from less than ten to over 450/ha. With such an extreme range in mouse density, both long term trends and abnormal conditions may be difficult to detect.

While there are many fewer data from San Miguel and Anacapa Islands, it is possible to make some predictions which might be useful in interpreting data from the first few years of monitoring. Population fluctuations on San Miguel should be rather modest, due to both the moderating influence of

island foxes and the more consistent amount of annual rain. Foxes are generalist predators, feeding on a wide variety of animals and plants including mice, lizards, crickets, and ice plant fruits and flowers. Since there are many alternative foods for foxes, they should be able to switch from mice to other prey as the mouse population declines.

Deer mouse populations on Anacapa Island are likely to fluctuate in an intermediate range when compared with Santa Barbara and San Miguel islands. This is because both annual rainfall and perennial vegetation on Anacapa provide a more stable environment.



## ISLAND FOX

### Methods

The monitoring of island foxes employs five, mark-recapture grids on San Miguel Island. Table 4 shows the trapping schedule for each grid. The location of these grids is shown in Appendix B, Figures 4- 6.

Fox grids consist of five rows of five traps spaced 0.32 km (0.2 mi) apart. Hence each grid measures 1.29 km (0.8 mi) on a side. Trapping stations are marked in the field with a one-meter-high piece of rebar. Each piece of rebar has a metal tag (marked with the trap site number) tied to the base of the stake. This is useful since transects for other research on the island have also been marked with rebar. Until one is familiar with the location of each trap site, it will be easiest to start at an obvious landmark and then locate the others from there. Specific suggestions are given for each transect in Appendix B. Use a high quality sighting compass to determine the direction of travel. It is handy to carry binoculars to look for the rebar stake once you have reached the expected location. Tying a short length of flagging tape on the top of the rebar is helpful when locating the site on successive days.

Foxes are trapped using Tomahawk #205 collapsible live traps that measure 26 x 9 x 9 in. Traps are left open for eight days and checked once a day. Each trap should be examined when it is put out to be sure it is operating properly. Adjustments to the treadle or associated bars are generally simple, but a sturdy pair of pliers may be needed. Once the traps have been adjusted they tend to remain functional for a long time, but they should be checked daily, especially after a fox has been caught.

Since it will take more than one day to distribute all 25 traps to the appropriate sites, do not open the traps until the last day when you can set all 25. The trap should be placed in the immediate vicinity of the stake and baited with fish-flavored, canned cat food. One 13 oz. can is sufficient for three to four traps. The bait is put on a 10 x 10 cm piece of brown paper cut from a standard grocery bag. The paper and bait are then placed in the far end of the trap. The bait tends to dry out, especially in warm weather so it helps to add a small amount of fresh

| Grid | Habitat | Month | Frequency |
|---|---|---|---|
| **San Miguel Island** | | | |
| Green Mountain | Grassland | April | Yearly |
| Harris Point | Stable Dune | February | Odd years |
| Point Bennett | Stable Dune | February | Even years |
| San Miguel Hill | Rock/Canyon | March | Yearly |
| Willow Canyon | Grassland | Mar/Apr | Yearly |

**Table 4. Island Fox Monitoring Schedule.**

bait and mix it in on each successive day that the traps are open. Also, some traps may be robbed so it is important to carry replacement bait.

Wrap each trap in a piece of burlap (approximately 36 x 50 in.) so that only the door is exposed. If there is a strong wind, a rock may be placed on top of the trap to keep the burlap in place. Be sure the rock is not so heavy that the trap is distorted. If the trap opening is not square, the door may not be able to close completely and the fox will escape. The effect of wind on captured foxes can be reduced if the long dimension of the trap is placed perpendicular to the direction of the prevailing wind. Otherwise, the wind tends to blow through the trap door which is not covered with burlap. Since some foxes chew on the burlap, it is important to carry several replacement pieces when traps are being checked.

The first step in processing a fox is to weigh the trap (with the fox in it) using a Pesola spring scale. The burlap should remain around the trap if possible since this keeps the fox calmer. Pups can be taken out of the trap and wrapped up in a bandanna or placed in small bag to obtain a more exact weight, but it is best to get a preliminary weight while the animal is still in the trap. Once the fox has been processed and released, weigh the trap (with burlap) so you can determine the fox's weight by subtraction. Data are recorded on the forms shown in Appendix D-3.

If a fox is already collared, attempt to read the number on the collar to determine whether it is necessary to handle the animal and to assure that the number is recorded in case of an escape. This is best done with a small dowel that can be used to poke into the trap and move the fox's fur away from the collar. It is generally not possible to read a number without moving the fur. It is not possible to read numbers on the more active animals.

To remove a fox from a trap, first stand the trap on end, preferably with the burlap still wrapped around it. Especially at first, it is helpful to carry a 3/8 in. dowel to use in cornering the fox. The dowel can be inserted through the side near the bottom of the trap (just above the fox) and used to gently press the fox's neck down and thus restrict its movement momentarily. The next step is simply to reach in and grab the fox right behind the head. You may or may not want to wear a glove for this step. A glove provides some protection if the fox tries to bite, but it also reduces both your ability to get a grip on the animal and your feel for when the fox is likely to jump or struggle.

Once a fox has been removed from the trap, it is best to handle it without gloves. The most convenient way to handle a fox is to sit cross-legged on the ground with the fox in your lap. Most foxes are fairly calm during processing. Excitable animals can be blindfolded with a bandanna loosely tied around the eyes and behind the head. It is important that loud, sudden noises be kept to a minimum since the fox is likely jump and may escape. Note that loud, low-flying military aircraft may appear unexpectedly.

Unmarked animals should first be marked with either a collar or an ear tag. Pups less than eight months old (June through the following February) are tagged with #4 National ear tags. The tag is applied with pliers that are sold with the tags. The tag should be at the base of the ear and as far into the center as possible without folding the outer edge of the ear. Past researchers have used the convention of tagging females in the left ear and males in the right ear. This might facilitate the identification of pups seen at a later time.

Apply Neosporin to the pierced part of the ear. If a fox with an ear tag is recaptured when it is large enough for a collar, a collar should be fitted. After the collar is put on, remove the ear tag with a pair of side-cutters. Do not remove the tag prior to applying the collar. Be sure to make a clear notation on the data form that the fox number has been changed. Carefully examine the ear after removing a tag. Clean the ear with water and apply Neosporin as needed.

Older pups and adult foxes are fitted with a numbered collar made from a 12 mm wide cable tie. The collars must be carefully prepared in advance. Stamp each collar with a consecutive number. The collar is then bent at least 90° at 2 cm intervals for the entire length so that it assumes a round shape when put on. Collars must be fairly tight, leaving just enough room barely to fit two fingers between the fox's neck and the collar. If the collar is too loose, the fox can pass a front foot through the collar and become permanently entangled. A piece of duct tape is wrapped around the collar adjacent to the holding mechanism to assure that the collar does not slip. Cut off the extra with a sturdy pair of side cutters. Then fill the holding mechanism with

Shoe Goo to hold the collar permanently. The glue dries to the touch in a few minutes and cures in 24 hours. The duct tape will hold the collar in place until the glue dries.

Once a fox is tagged, it should be aged by examining the teeth. Aging foxes is more of an art than an exact science. It is best learned from someone with a lot of experience, but some guidelines are offered below. Open the fox's mouth with a small dowel or retractable pen. Pens work well because they are sturdy, cheap, and soft enough that the fox is not likely to damage its teeth or gums if it bites. Once the mouth is open, the pen can be held across the back of the mouth to prevent it from closing. Age is determined based on tooth wear and to a lesser extent canine color. Appendix C summarizes the basic features to look for. Additional data on sex, parasites, injuries, and shedding should also be recorded.

The Daily Summary form (Appendix D-4) is used to record the name of the grid being trapped, the number of trap nights and the number of foxes captured.

## Equipment Needed

Pen with waterproof ink and clipboard
Data form
Binoculars for locating grid stakes
Tomahawk traps (#205)
Burlap
Canned cat food - fish flavored
Can opener
Fork or spoon
10 x 10 cm squares of brown paper (grocery bag)
Cable tie collars (with stamped numbers)
Pliers
Side cutters
Shoe Goo (available at athletic shoe stores)
Duct tape
Bandanna
Pen or dowel to open mouth
Ear tags
Ear tag pliers
5 kg Pesola scale for adults in trap
100 g Pesola scale for pups in bag
Neosporin for ear tag injuries and fox bites
Water to clean injuries
Compass

Optional:
Leather gloves
3/8 in. dowel
Vials with 70% alcohol for parasites
Plastic bag for weighing pups

Lab equipment:
1/4 in. steel die numbers to stamp fox collars
Hammer

## Special Considerations

Each grid should be trapped at the same time each year because population size varies seasonally. This variation can affect estimates of population size. For comparisons between years to be valid, the estimates must be at the same stage of the annual cycle. Trapping in the late winter and early spring avoids the summer pupping season and also the fall and early winter when males tend to wander more. Trapping should not be done in May or June since female foxes might either be in the late stages of pregnancy or nursing pups.

Burlap is remarkably effective in absorbing rain and reducing the effects of wind, but trapping should not take place when inclement weather is expected. These conditions would include either extremely warm weather or more than a light rain.

Rabies has not been reported from any of the Channel Islands, but it could be present on an occasional basis due to transmission by bats or dogs. Preventative rabies vaccines consist of a series of shots in the arm given over a period of several weeks. It is strongly recommended that personnel involved in handling foxes should be vaccinated. The chance of contracting the disease is slight, but this must be balanced against the fact that, once rabies develops, it is almost invariably fatal. The current series of rabies shots is not particularly painful and hence no longer merits its bad reputation.

## Data Input

Data for each grid are entered into a computer data base using the FOX.PRG program which runs from within dBase III and uses the FOX.DBF for the file structure. After starting dBase, begin the program by typing:

**DO FOX**

The program prompts the user for information as displayed on the data form. It is easiest to store and analyze data if they are stored in a separate file for each trapping session for each grid. Hence, if you are entering February, 1989 data for the Harris Point grid, you might name the file HP_FEB89.DBF. If the file does not exist, a new file is created based on the structure of the FOX.DBF file (which needs to be present in the same subdirectory). If the file already exists, it is opened and you can add more data. Once the file has been opened, the program prompts the user for information as displayed on the data form.

The appropriate abbreviations for the fox grids are as follows:

| | | |
|---|---|---|
| GM | = | Green Mountain |
| HP | = | Harris Point |
| PB | = | Point Bennett |
| SM | = | San Miguel Hill |
| WC | = | Willow Canyon |

Inappropriate grid abbreviations are not allowed by the FOX program.

After entering all of the data, it is essential to print and proofread these data prior to analysis. Data can be edited using the dBase edit and browse commands. Also note that any fox numbers that have changed (because collars or tags were replaced) must be corrected in existing data bases.

## Data Analysis

### Population Size

Population size is calculated using the CAPTURE.EXE program. There are two steps to running the CAPTURE program.

1. Convert the dBase file to the proper format for analysis.

2. Run the CAPTURE program.

Two programs have been written to automate these steps. The input file for CAPTURE is created using the dBase program FOX_C.PRG. To run it, start dBase and type:

**DO FOX_C**

The FOX_C program asks for the name of the data file and then proceeds with the data conversion. Messages on the screen keep you posted as to the status of the conversion. The file created by the FOX_C program has the same name as the original file, but the extension is SDF. Thus if the data file is HP_FEB89.DBF, the temporary file would be HP_FEB89.SDF.

The second step is carried out at the DOS prompt. A batch file, CALC.BAT, has been provided to run CAPTURE. The data file must have the extension SDF and the output file will have the same name as the input file and an OUT extension. To run CALC, make sure that the data file and the CAPTURE program are in the same subdirectory of a hard disk and then type CALC and the filename with no extension. Hence if the data file is HP_FEB89.SDF, you would enter:

**CALC HP_FEB89**

After about a minute, the screen should return the message "Capture Successful Execution" and a note about the output file. The output file in this example would be called HP_FEB89.OUT. This file must be printed on a wide-carriage (132 character) printer. A complete discussion on reading the output file and statistical interpretation is provided in Appendix I.

The population size calculated by CAPTURE should be plotted on a graph. It would be best to use a line graph (population size versus time) with each line representing one grid.

Short-term changes in population indices can be examined by comparing the current with the previous year's population index using a t-test. Long-term trends are analyzed using autoregressive time series analysis (Edwards and Coull 1987). This technique is appropriate for detecting trends in autocorrelated time series data such as will be collected as part of the monitoring program.

### Weight, Sex, and Age

Data on weight, sex, and age can be useful in interpreting trends in population dynamics. These data do not need to be analyzed statistically, but they

should be summarized and graphed for each trapping session as follows:

Weight data are tabulated as the average weights for both adult males and adult females. These data are plotted as average weight for each sex versus time. A separate graph is prepared for each grid.

Sex data are tabulated as the number of males, number of females and the male:female ratio for each trapping session. These data are then plotted as proportion of males versus time.

Age data are tabulated as both the total number and the percent of each age class. The percentage of each age class is then plotted for each grid versus time.

Injuries are tabulated as the number and percent of individuals having eye, mouth, or body injuries. While these are fairly broad categories, the goal is to be able to detect any major change in injury rates. The tabulated data are then plotted as injury rate for each category versus time.

Shedding data are tabulated as number and percent of individuals which are shedding. These data are plotted as percent of individuals shedding versus time.

Statistical analysis of the above data would be useful primarily if the population data indicate a significant trend. Otherwise, the importance of collecting these data is in establishing a baseline for future comparisons. Note that the statistical analysis of these data is complicated by the fact that the data are not independent. Many of the foxes will be the same from one session to the next.

## Interpretation of Data

Fox trapping was conducted during the design studies from 1985-1987. The total captures ranged from a low of two foxes/100 trap nights to 26 foxes/100 trap nights.

The fox monitoring program will allow the park to document natural population fluctuations as well as to watch for unexpected changes in the island fox population on San Miguel Island. As generalist predators with a very diverse diet, it is expected that the numbers of island foxes will be relatively stable. It will, however, require several years of data to determine the normal range of natural fluctuations. In the meantime, any marked change in population size or indicators of individual conditions (weight, parasites, or reproductive condition) warrants a careful examination of both the fox data and data from other parts of the monitoring program which might reasonably be expected to affect foxes (e.g. weather, invertebrate food, mouse population levels, and vegetation changes).

As with other vertebrate populations, long-term changes in distribution and number may occur with significant shifts in the vegetation communities on the island. The monitoring program will allow the park to document such changes.

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## APPENDIX A. Schedule of Species Monitoring by Island

| Island | Species | Month | Frequency |
|---|---|---|---|
| **East Anacapa** | | | |
| All Locations | Amphib/Reptiles | Dec, Jan, Apr | Yearly |
| All Locations | Deer Mice | August | Even Years |
| **Middle Anacapa** | | | |
| All Locations | Amphib/Reptiles | Dec, Jan, Apr | Yearly |
| All Locations | Deer Mice | Mar/Apr | Yearly |
| **West Anacapa** | | | |
| All Locations | Amphib/Reptiles | Dec, Jan, Apr | Yearly |
| All Locations | Deer Mice | Mar, Aug | Yearly |
| **Santa Barbara** | | | |
| All Locations | Amphib/Reptiles | Apr, May, Jun | Yearly |
| All Locations | Deer Mice | Mar, Aug | Yearly |
| **San Miguel** | | | |
| All Locations | Amphib/Reptiles | Dec, Jan, Apr | Yearly |
| Air Strip | Deer Mice | Apr, Sep | Yearly |
| Green Mountain | Deer Mice | Apr, Sep | Yearly |
| Nidever | Deer Mice | Apr, Sep | Yearly |
| Harris Point | Deer Mice | Apr, Sep | Odd Years |
| San Miguel Hill | Deer Mice | Apr, Sep | Even Years |
| Point Bennett | Deer Mice | Apr, Sep | Odd Years |
| Green Mountain | Foxes | Apr | Yearly |
| Harris Point | Foxes | Feb | Odd Years |
| Point Bennett | Foxes | Feb | Even Years |
| San Miguel Hill | Foxes | Mar | Yearly |
| Willow Canyon | Foxes | Mar/Apr | Yearly |

# ANACAPA ISLAND BOARD AND GRID LOCATIONS

## East Anacapa Island

### Amphibian and Reptile Board Transects

Inspiration Point. This transect begins 8 m from nature trail marker #7 and is oriented 266° from this point (roughly west). The second row of boards lies to the north of the first row.

Lighthouse. This transect runs at 72° (roughly east) from the flagpole near the ranger residence. The first board is 15 m from the flagpole. The second row of boards lies to the north of the first row.

## Middle Anacapa Island

### Amphibian and Reptile Board Transects

Grassland. This transect runs along the trail from Sheep Camp on the main terrace with the first board just north of the Deer Mouse grid. While the spacing is approximately 5 m between boards, the transect is not straight. Note that the transect consists of only 30 boards.

Sagebrush. This transect is located in an area of sagebrush on the bluff overlooking East Fish Camp. It is to the east of the Grassland transect. Note that the transect consists of only 30 boards.

### Mouse Grids

Middle Anacapa Grid. The grid is near the center of Middle Anacapa, SE of the head of Sheep Camp. This is the canyon with a small grove of *Eucalyptus* where you will land on the island. The grid is oriented on a north-south axis with stake 1,1 in the NE corner and stake 1,10 in the NW corner.

## West Anacapa Island

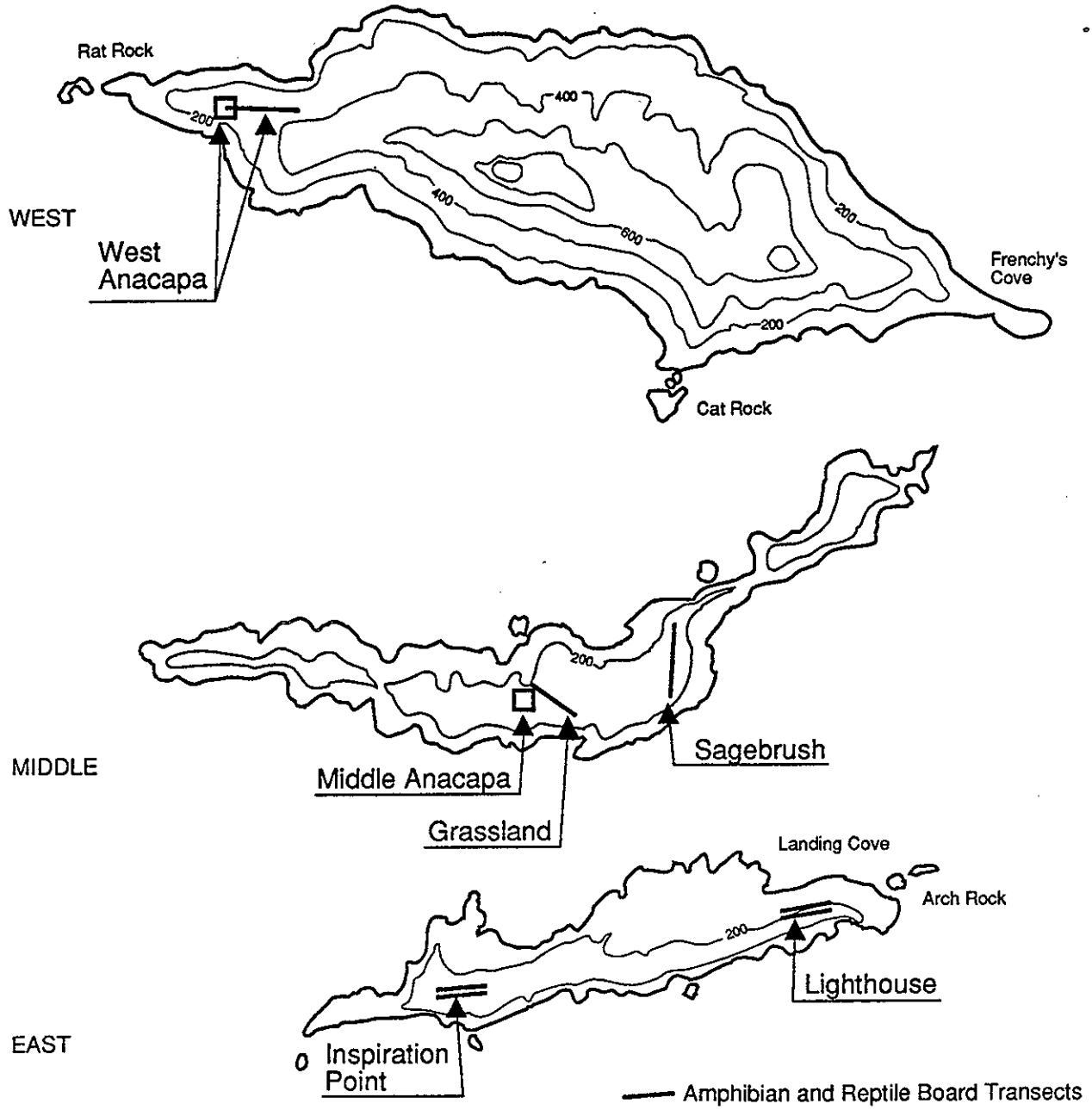
### Amphibian and Reptile Board Transects

West Anacapa. This transect runs to the east along the southern edge of the mouse grid. Board 1 is at mouse stake 1,3. The second row of boards lies to the south of the first.

### Mouse Grid

West Anacapa Grid. The grid is located on the small terrace toward the west end of West Anacapa at the top of the rocky ridge leading up from Rat Rock. Stake 1,1 is in the NW corner of the grid and stake 10,1 in the NE corner. The antenna for the seismic station is located along the western side of the grid, 60 cm south of stake 1,4. The orientation of this grid is fairly obvious since the vegetation is low.

**APPENDIX B - 1 Figure 1. Map of Monitoring Locations**




# ANACAPA ISLAND

## Vertebrate Board Transect and Trapping Grid Locations

# SANTA BARBARA ISLAND BOARD AND GRID LOCATIONS

## Amphibian and Reptile Board Transects

Cave-Middle. Three parallel rows of 20 boards each are located on the terrace between Cave and Middle Canyons. The rows are spaced approximately 10 m apart and run toward the east. Spacing between boards is approximately 5 m. Board 1 is at the west end of the southern row, approximately 250 m east of the saddle trail, starting from the vicinity of the bridge. Board 60 is at the east end of the northern row.

Middle Canyon. The transect consists of 40 boards in the upper part of Middle Canyon. It begins at the head of the canyon and extends toward the mouth. Board 1 is at a small stand of *Artemisia californica* on the south facing slope. The boards continue down the canyon along the base of the south-facing slope. Note that there is a parallel row of boards on the opposite slope. Those boards are part of the invertebrate monitoring program and should not be disturbed since rare snails aestivate under cover on the cooler north facing slopes.

Middle-Graveyard. This transect is located between Middle and Graveyard Canyons. Board 1 is SW of the old trail that crosses lower Middle Canyon. From there, the transect continues toward Graveyard Canyon at 344°. The parallel transect lies to the west.

Terrace Grassland. This transect is located in the grassland area between the upper saddle trail and the trail to the Badlands. The first board is reached from the "Y". Proceed 30 m to the south (toward the Badlands) and then about 80 m west into the grassland. The first board is at stake 10,5 along the south side of the mouse grid. The second row of board lies to the west of the 1-30 row. Spacing between boards is 5 m.

Webster Point. This transect is found by going to the north corner of the Webster Point deer mouse grid (station 10,10). Boards 10 and 11 are on either side of this stake. Boards 1 through 10 are located in a direction of 289° from station 10,10 and Boards 11 through 30 are at 109°. The second, parallel row is to the north.

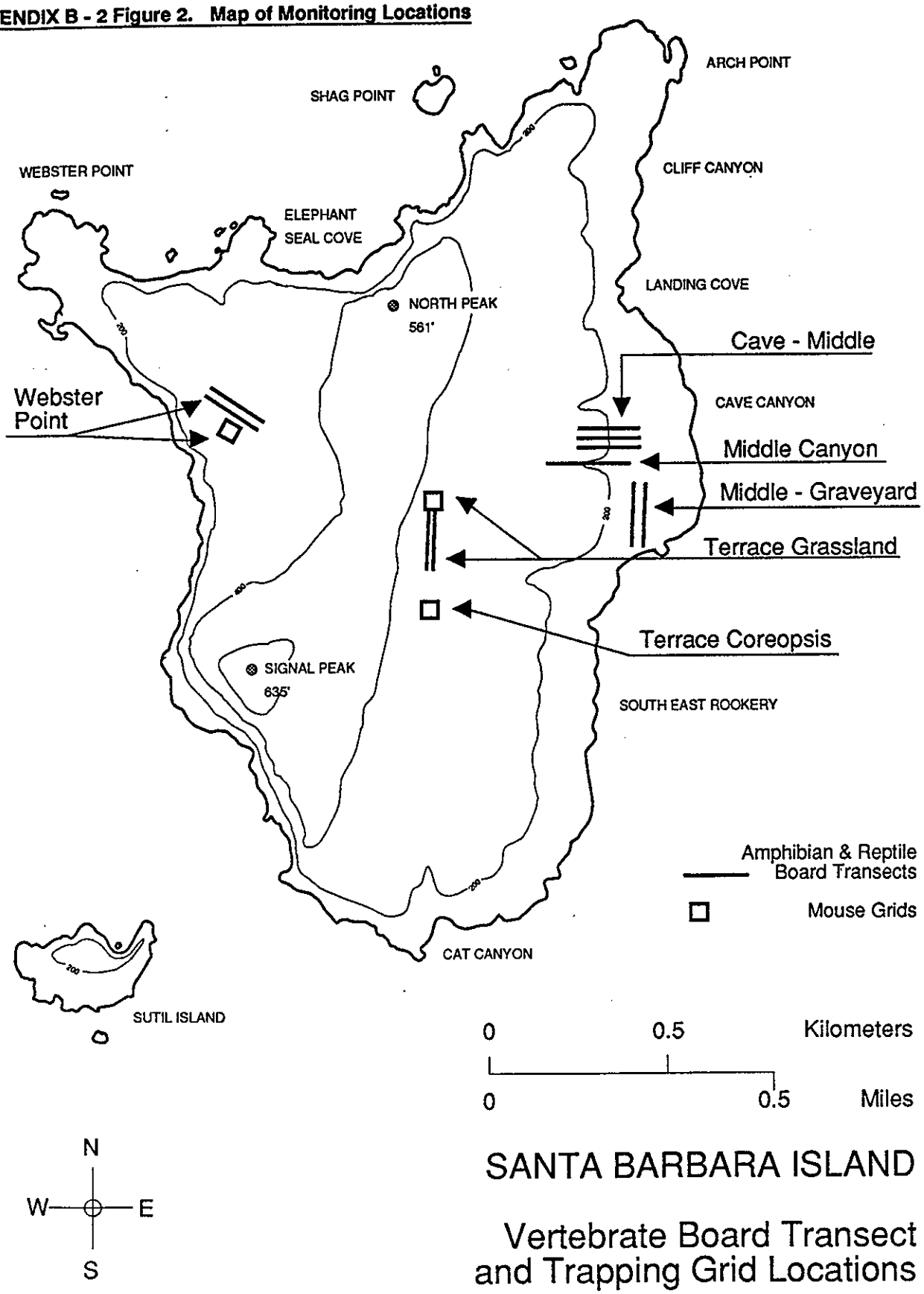
## Mouse Grids

Terrace *Coreopsis*. This grid is located south of the grassland grid in the large *Coreopsis* stand north of the Badlands. The grid is SW of the head of Graveyard Canyon and west of the trail to the Badlands. From the "Y" in the saddle trail, walk south 500 m toward the Badlands. Then go west from the trail about 30 m out into the grassland to the NE corner of the grid. Stake 1,1 is at the NE corner of the grid and stake 1,10 is at the NW corner.

Terrace Grassland. This grid is located WNW of the head of Graveyard Canyon, in the east terrace grassland. It is north of the large Coreopsis stand to the north of the Badlands. From the "Y" in the saddle trail, walk south 250 m toward the Badlands. Then go west from the trail about 50 m out into the grassland. Stake 1,1 is at the NE corner of the grid and stake 1,10 is at the NW corner.

Webster Point. This grid is east of the Elephant Seal Cove trail where it runs along the top of the west-facing cliffs on the west side of the island. After descending from the saddle onto the west terrace, proceed along the trail about 140 m beyond the north edge of the old cistern. At that point, turn to the east and proceed about 80 m toward North Peak. This will bring you to the south corner of the grid which is station 1,1. The sides of the grid are oriented 23° and 293° from the south corner. The east corner of the grid is station 1,10.

**APPENDIX B - 2 Figure 2. Map of Monitoring Locations**



# SAN MIGUEL ISLAND BOARD AND GRID LOCATIONS

## Amphibian and Reptile Board Transects

Air Strip. This transect is located within the Willow Canyon fox grid. Board 1 is adjacent to fox grid stake 36. The transect runs to the east from that point with a compass heading of 89° from true north. The parallel row of boards (31-60) lies to the south of the 1-30 row.

Green Mountain. This transect is located within the Green Mountain fox grid. Board 1 is adjacent to fox grid stake 88. The transect runs to the west with a compass heading of 270°. The parallel transect lies to the north.

Nidever. This transect is located within the San Miguel Hill fox grid. Board 1 is 32 m at 89° from fox grid stake 3. The transect runs to the east toward the antenna of the seismic station. The parallel row of boards lies to the north. Many of the boards in this transect are inconspicuous because of the dense vegetation.

San Miguel Hill. This transect is located within the San Miguel Hill fox grid. Board 1 is adjacent to fox grid stake 13. The transect runs to the west with a compass heading of 269°. The parallel row of boards lies to the north. The layout of this transect is conspicuous because of the low vegetation.

Willow Grassland. This transect is located within the Willow Canyon fox grid. Board 1 is adjacent to fox grid stake 38. The transect runs to the west with a compass heading of 269° from true north. The parallel transect lies to the north.

## Mouse Grids

Air Strip. This grid is located within the Willow Canyon fox grid, just north of the trail going east from the end of the air strip. Mouse stake 10,1 is 32m at 108° from fox grid stake 36. The mouse grid lies to the north of that point with grid stake 1,1 at the NW corner of the mouse grid.

Green Mountain. This grid is located within the Green Mountain fox grid. Mouse stake 1,1 is in the NW corner of the grid and mouse stake 1,10 is adjacent to fox grid stake 88.

Harris Point. This grid is located within the Harris Point fox grid. The mouse grid is centered around fox stake 63 such that mouse stake 6,5 is adjacent to fox grid stake 63. Mouse stake 1,1 is the northern corner of the grid. The layout of this mouse grid is conspicuous since there is only low vegetation in the vicinity.

Nidever. This grid is located within the San Miguel Hill fox grid. Mouse stake 10,10 is 50 m at 31° from fox grid stake 3. The rest of the grid lies to the north with mouse grid stake 1,1 at the NW corner of the mouse grid.

Point Bennett. This grid is located within the Point Bennett fox grid. Mouse stake 1,1 is in the NW corner of the grid, adjacent to fox grid stake 113. The layout of this grid is conspicuous since the vegetation is low.

San Miguel Hill. This grid is located within the San Miguel Hill fox grid. Mouse stake 1,1 is in the NW corner of the grid adjacent to board 26. (Note that board 26 is numbered, unlike other board transects where only the end boards are numbered.) Mouse stake 1,10 is approximately 60 m west of fox stake 13 at 90°. The layout of this grid is conspicuous since there is only low vegetation in the vicinity.

Willow Canyon. This grid is located within the Willow Canyon fox grid. Mouse stake 1,1 is in the NW corner of the grid and stake 1,10 is adjacent to fox grid stake 38.

# SAN MIGUEL ISLAND BOARD AND GRID LOCATIONS - continued

## Fox Grids

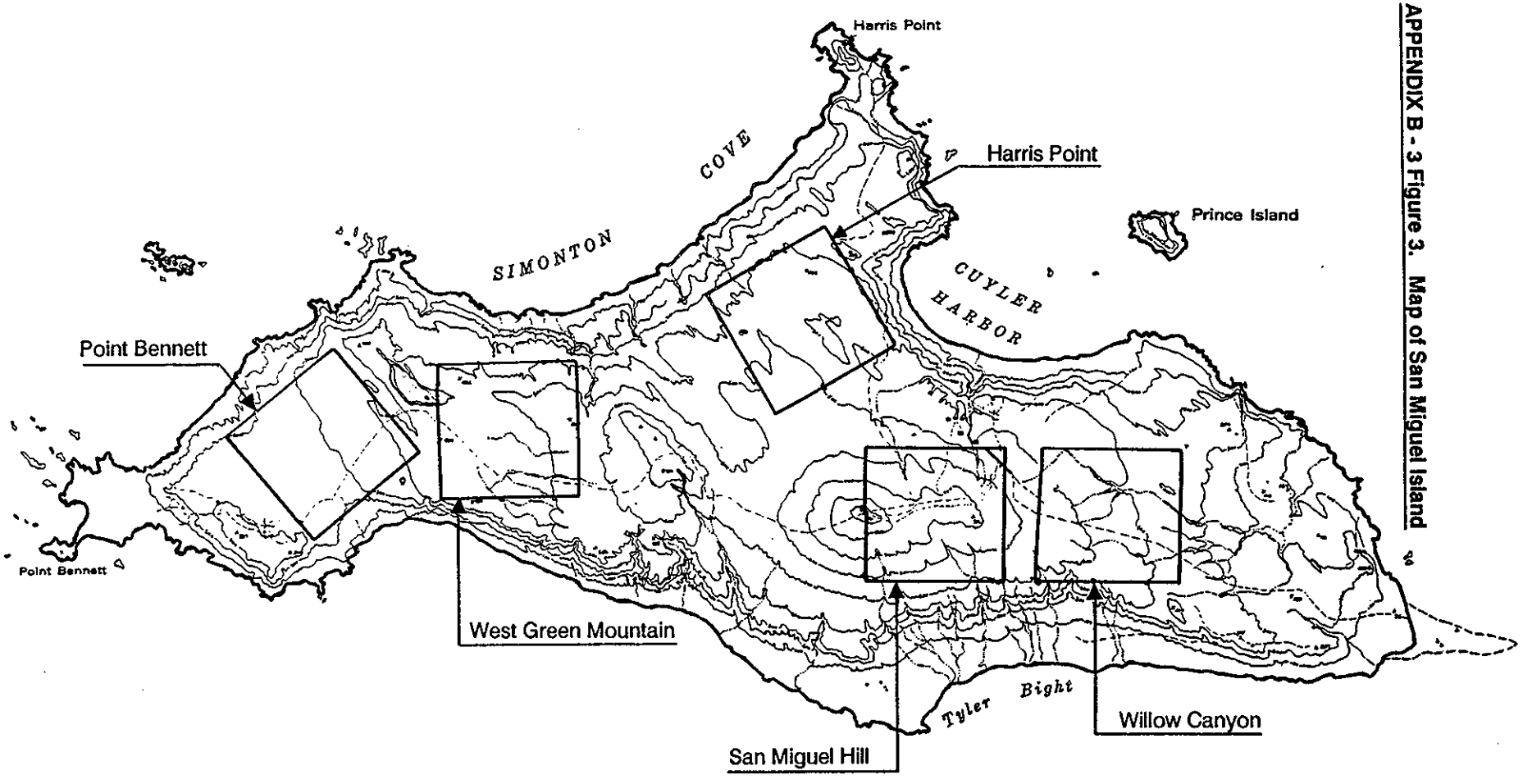
Green Mountain. This grid is located on the broad western slope of Green Mountain. The stakes are numbered 76-100. The grid is oriented due north and south. The easiest stakes to locate are those near the trail such as 86 and 92.

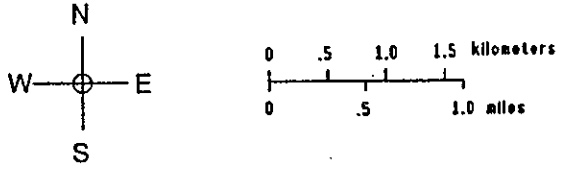
Harris Point. This grid is located on Harris Point. The grid stakes are numbered 51-75. The grid is oriented 60° to the west of true north (rotated counter clockwise). Hence, in traveling from stake 51 to 52, one would follow a compass heading of 300° (360° minus 60°). Stakes 74 and 75 are easiest to find since they are close to the route one would be following when hiking from the Nidever Ranger Station. Stake 65 is conspicuously located on the top of a slight hill and stake 63 is in a broad valley.

Point Bennett. This grid lies to the east of the Research Station. The stakes are numbers 101-125. The grid is oriented 48° west of true north (rotated counter clockwise). Hence, in traveling from stake 101 to 102, one would follow a compass heading of 312° (360° minus 48°). The western edge is approximately 0.2 miles east of the station. Stakes 116 and 117 are easy to locate since they are adjacent to the trail to the dry lake.

San Miguel Hill. This grid is positioned on the eastern slope of San Miguel Hill. It is marked with stakes 1-25. The grid is oriented at 1° west of true north (rotated counter clockwise). The west edge of the grid crosses the summit of San Miguel Hill. Stake 11 would have been placed at the surveyor's mark at the summit of the hill, but the presence of a brass survey marker superceded the need of an additional stake. Stake 1 is at the NW corner of the grid. Stakes 12 and 13 are just south of the trail to the east of the summit and are easily located.

Willow Canyon. This grid lies adjacent and 0.2 miles to the east of the San Miguel Hill grid. The stakes are numbered 26-50. The Willow Canyon grid is also oriented at 1 degree west of true north (rotated counter clockwise). The easiest stake to locate is 36 which is just south to the trail going east from the end of the air strip.



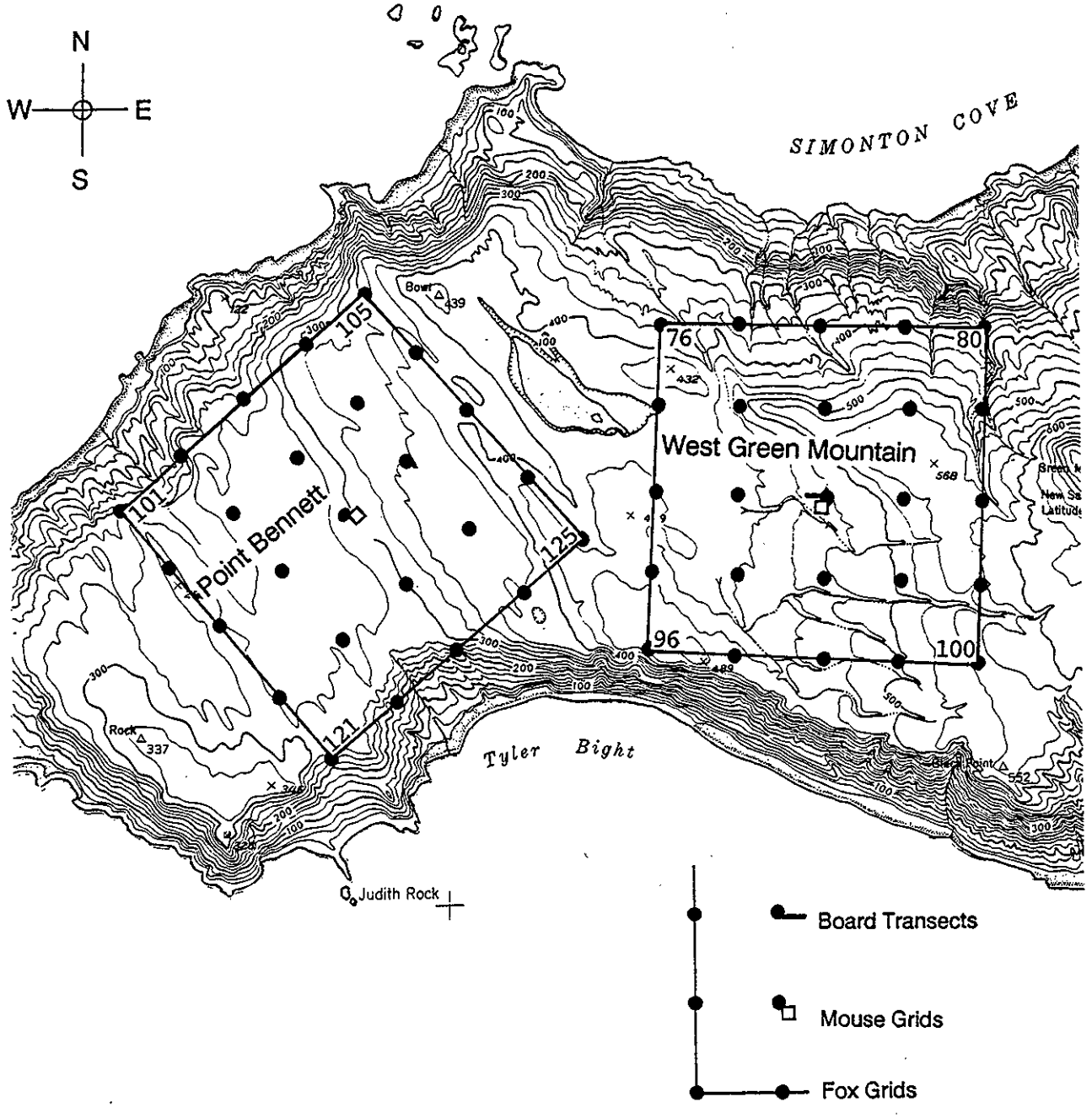




**APPENDIX B - 3 Figure 3. Map of San Miguel Island**

# SAN MIGUEL ISLAND

## Fox Grid Locations

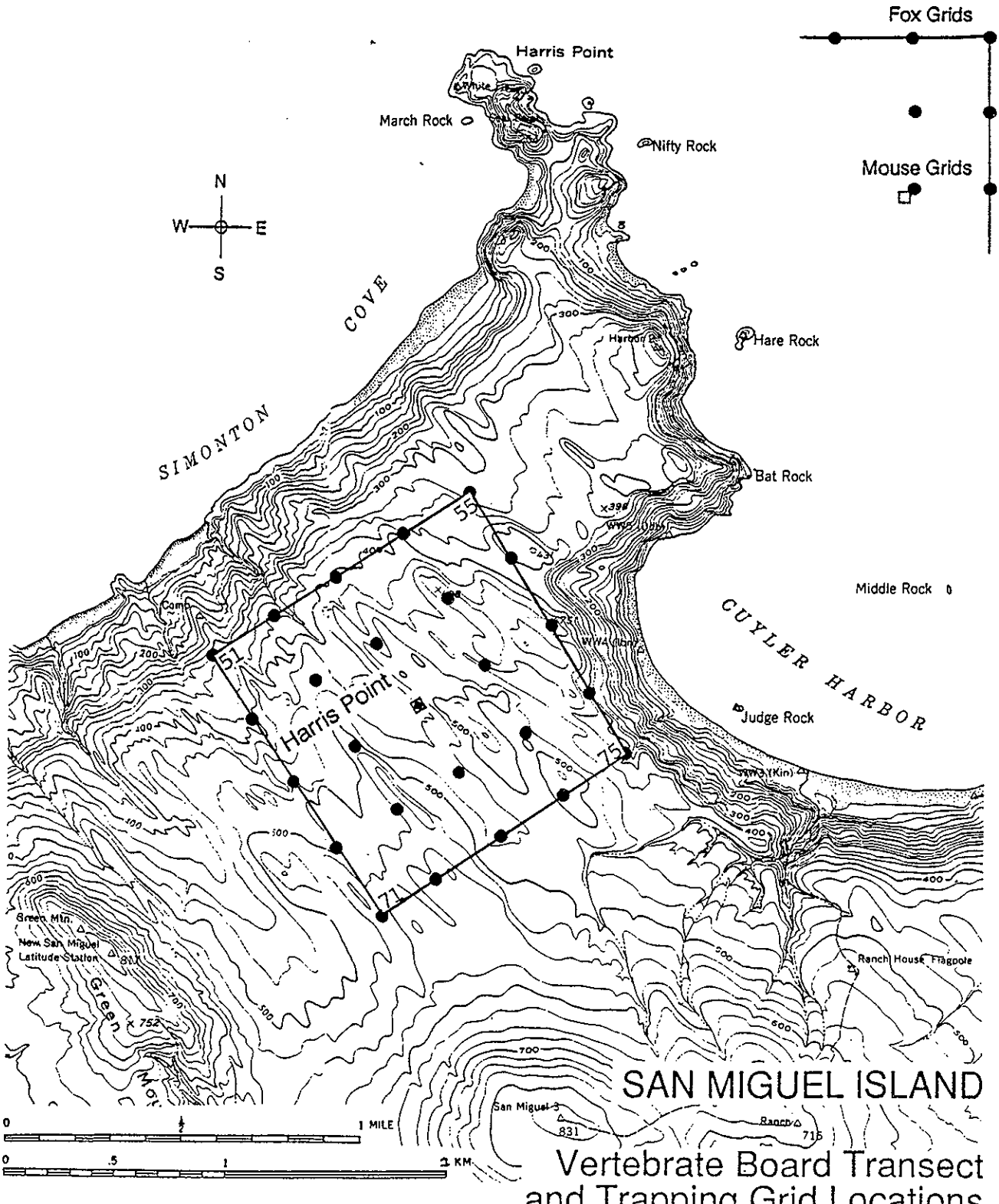
**APPENDIX B - 3 Figure 4. Map of Monitoring Locations**



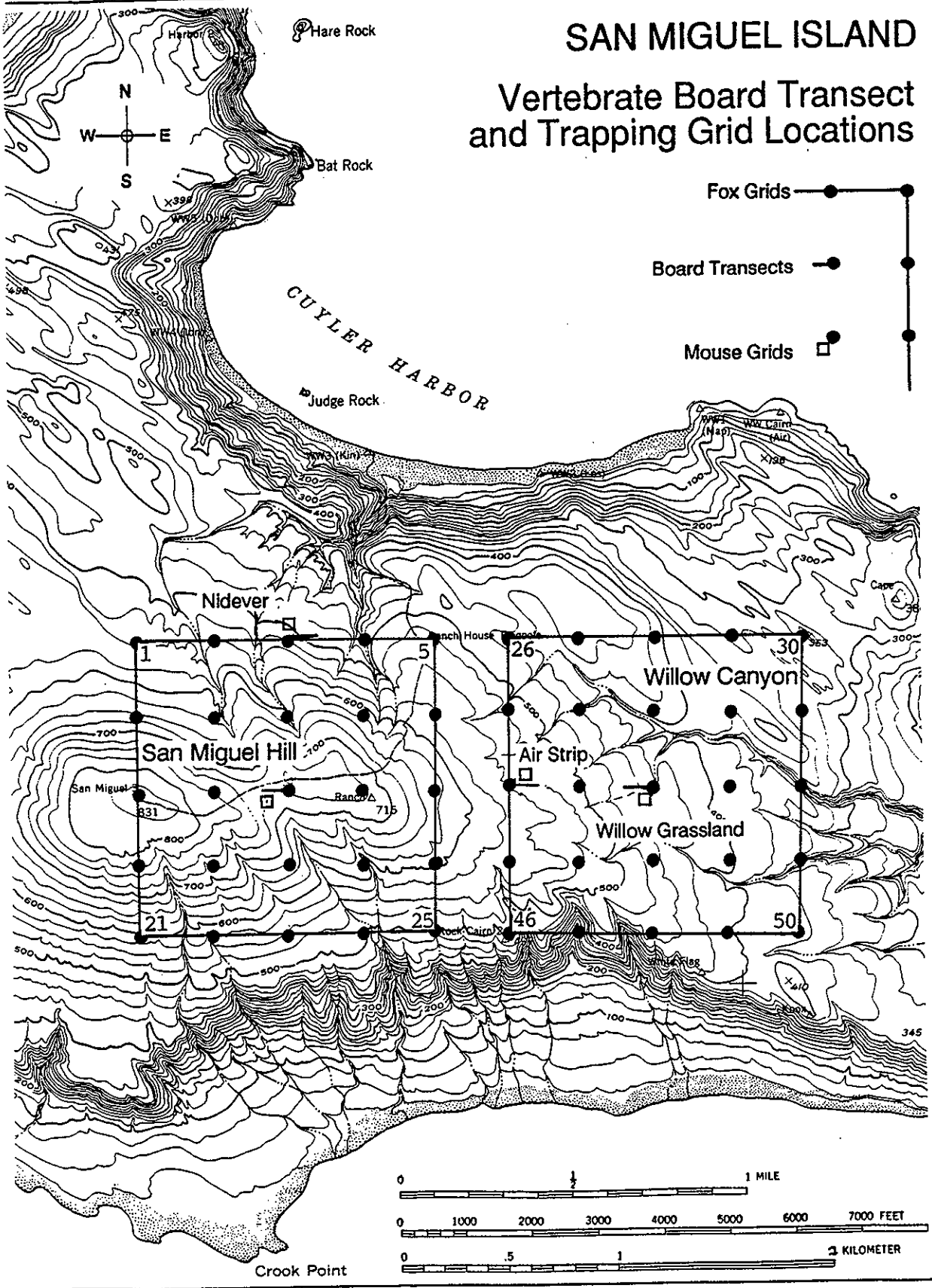

# SAN MIGUEL ISLAND

## Vertebrate Board Transect and Trapping Grid Locations

**APPENDIX B - 3 Figure 5. Map of Monitoring Locations**



**APPENDIX B - 3 Figure 6. Map of Monitoring Locations**



| AGE | DENTAL CHARACTERISTICS |
|---|---|
| 0-1 yr | Adult dentition partially to mostly erupted (3P3 may not be in). If incisors in, serrations present along top edge. Sharp appearance to cones and conules (=small cones) on all molars, no significant wear apparent. |
| 1-2 yr | Adult dentition present. Incisors without serrations along top edge. Fairly sharp appearance to cones and conules on all molars, but slight wear beginning on M1 protocone and metaconule. Normally a fair bit of discoloration at tip of canine. |
| 2-3 yr | Teeth have for the most part lost "sharp" appearance. M1 enamel worn some on protocone and metaconule as well as other cusps, but little or no dentine showing. Normally a fair bit of discoloration at tip of canine. |
| 3-4 yr | Moderate enamel wear on all cusps of molars. A narrow crescent-shaped band of exposed dentine begins to connect the metaconule and protocone on M1. |
| 4-5 yr | All molar cusps showing significant enamel wear. M1 exposed dentine connecting the metaconule and protocone becoming wide band. |
| 5 yr | M1 dentine is continuous across molar surface. |
| 5+ yr | Dentine is continuous across molar surface. Cones and conules worn down to depth of inter-conule space. All teeth with very worn appearance, generally worn to gum. |

See Ingles (1965) for tooth terminology.

# AMPHIBIAN AND REPTILE DATA ENTRY FORM

**Amphibian and Reptile Data Form**

Date 5-30-88 Island Santa Barbara Transect Webster Observer C. Drost

| Board | Species | Length | Weight | Comment |
|---|---|---|---|---|
| 3 | XR | 91 | 19.6 | Stripe Pattern |
| 8 | XR | 46 | 9.4 | 4-5mm scar on tail |
| 8 | XR | 65 | 12.2 | Rt. eye cloudy |
| 16 | XR | 53 | 11.4 | |
| | | | | |
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| | | | | |
| | | | | |

# DEER MOUSE DATA ENTRY FORM

**Deer Mouse Data Form**

Date 1-29-88 Island Middle A1 Transect Grass Observer C. Drost

| Trap | Tag | Age | Sex | Wt | Trap | Tag | Age | Sex | Wt | Trap | Tag | Age | Sex | Wt |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,8 | 214 | S | m | 16.1 | | | | | | | | | | |
| 4,7 | 148 | A | F | 18.9 | | | | | | | | | | |
| 5,3 | 381 | A | F | 23.8 | | | | | | | | | | |
| 6,10 | 197 | A | M | 21.6 | | | | | | | | | | |
| 9,6 | 380 | S | F | 17.0 | | | | | | | | | | |
| 10,4 | 381 | A | M | 24.3 | | | | | | | | | | |
| 10,5 | 143 | A | F | 19.4 | | | | | | | | | | |

# ISLAND FOX DATA ENTRY FORM

## Island Fox Data Form

Observer G Fellers

| Fox # | Trap | Date | Weight | Sex | Age | Inj./Shed. | Parasites | Comments |
|---|---|---|---|---|---|---|---|---|
| 1042 | 3 | 2/19/88 | Gross 4.37<br>- Trap 2.14<br>= Fox 2.23 | M | 5+ | — | — | Photographed |
| 1043 | 6 | " | Gross 3.99<br>- Trap 2.16<br>= Fox 1.83 | F | 3 | shedding | - | missing upper right canine |
| 1053 | 12 | " | Gross 3.34<br>- Trap 2.31<br>= Fox 1.03 | F | 1 | Eye/ mucus | 6-8 lice | Replaced ear tag #33 with collar 1053 |
| 1054 | 22 | " | Gross 3.83<br>- Trap 2.23<br>= Fox 1.60 | M | 2 | — | — | |
| 1033 | 24 | " | Gross 4.60<br>- Trap 2.49<br>= Fox 2.11 | M | 5 | Broken premax. bone | — | |
| 1021 | 25 | " | Gross 3.99<br>- Trap 2.16<br>= Fox 1.83 | F | 4-5 | — | — | |
| | | | Gross<br>- Trap<br>= Fox | | | | | |
| | | | Gross<br>- Trap<br>= Fox | | | | | |

# TERRESTRIAL VERTEBRATE DAILY SUMMARY FORM

**Terrestrial Vertebrate Daily Summary**

Date 4/22/88 Observer G. Fellers

Weather (e.g. rain, wind, temperature, sky condition) Foggy in the morning; clearing by 10 AM, high ~ 75°

**Island Fox**

Grid SM Traps open 25 Number caught 6

**Deer Mice**

Grid — Traps open — Number caught —

**Amphibians and Reptiles**

Transect WC Numbers of boards checked 60

Number caught:

*Batrachoseps* 0 *Gerrhonotus* 12 *Sceloporus* 1

*Uta* — *Xantusia* —

Wildlife observations Peregrine Falcon seen at Hoffman Pt.

Comments Wind blew burlap off one trap.

# EQUIPMENT LIST FOR ALL SPECIES

## Amphibians and Reptiles

Pen with waterproof ink
Clipboard
Plastic sandwich bag for weighing animals
Wooden or metal 30 cm ruler
10 and 50 g Pesola scale
Water to moisten salamanders
Data forms

Optional:
- Walking stick or pole for locating boards
- One-gallon plastic jar - used on windy days to help weigh animals
- Vials with 70% alcohol for parasites
- Compass

## Deer Mice

Pen with waterproof ink
Clipboard
Sherman live traps
Rolled oats ("old fashion" variety)
Data forms
Ear tags - Size #1
Ear tag pliers - Size #1
50 g Pesola scale
Grease pen to mark traps moved to shade

Optional:
- Cotton gloves
- One-gallon plastic jar - used on windy days to help weigh mice
- Vials with 70% alcohol for parasites
- Compass

Lab Equipment:
- Spare trap doors

## Island Foxes

Pen with waterproof ink
Clipboard
Data form
Binoculars for locating grid stakes
Tomahawk traps (#205)
Burlap
Canned cat food - fish flavored
Can opener
Fork or spoon
10 x 10 cm squares of brown grocery bag
Cable tie collars (with stamped numbers)
Pliers
Side cutters
Shoe Goo (available at athletic shoe stores)
Duct tape
Bandanna
Pen or dowel to open mouth
Ear tags - Size #4
Ear tag pliers - Size #4
5 kg Pesola scale for adults in trap
100 g Pesola scale for pups in bag
Neosporin for ear tag injuries and fox bites
Water to clean injuries
Compass

Optional:
- Leather gloves
- 3/8 in. dowel
- Vials with 70% alcohol for parasites
- Plastic bag for weighing pups

Lab Equipment:
- 1/4 in. steel numbers set to stamp
- Hammer

## APPENDIX F. Source of Supplies

| EQUIPMENT/SUPPLIES | CATALOG # | SUPPLIER |
|---|---|---|
| Ear Tags - Fox | Tags - Cat. #4-1005, Size #4<br>Pliers - Cat. #4-1005S, Size #4 | National Band & Tag Co.<br>Newport, KY 41072 |
| Ear Tags - Mice | Tags - Cat. #4-1005, Size #1<br>Pliers - Cat. #4-1005S, Size #1 | |
| Fox Collars | Cat. #PLT5EH-O<br>Electrical Cable Ties | Panduit Corp.<br>17301 Ridgeland Avenue<br>Tinley Park, IL 60477 |
| Pesola Scales,<br>Steel Dies,<br>Metal Clipboards | | Forestry Suppliers<br>205 West Rankin Street<br>P. O. Box 8397<br>Jackson, MS 39204 |
| Traps - Fox | #205, 26 x 9 x 9 in. | Tomahawk Live Trap Co<br>P. O. Box 323<br>Tomahawk, WI 54487 |
| Traps - Mice | Large Folding | H. B. Sherman Traps, Inc<br>P. O. Box 20267<br>Tallahassee, FL 32316 |

Appendix G - 1. Computer Programs.

# LIST OF COMPUTER PROGRAMS

| | |
|---|---|
| HERP.PRG | (dBase III) |
| HERP.DBF | (dBase III) |
| MOUSE.PRG | (dBase III) |
| MOUSE_C.PRG | (dBase III) |
| MOUSE.DBF | (dBase III) |
| FOX.PRG | (dBase III) |
| FOX_C.PRG | (dBase III) |
| FOX.DBF | (dBase III) |
| CAPTURE.EXE | (DOS) |
| CALC.BAT | (DOS) |

```
      @ 20, 15 say 'The combination of island and';
            + ' species does not match.'
      @ 21, 15 say 'Press E  to edit entry.'
      @ 22, 15 say '      D  to delete this record';
            + ' and continue.'
      @ 23, 15 say '      X  to delete this record';
            + ' and exit program.'
      store 'Z' to choice
      set confirm off
      do while .not. choice  $ 'EDX'
       store ' ' to choice
       @ 24, 21 get choice picture '!'
       read
      enddo
      set confirm on
      if choice< >'E'
       loop
      else
       delete
       loop
      endif
     endif
     @ 21, 15 say 'Press  RETURN to add more data.'
     @ 22, 15 say '       E to edit entry.'
     @ 23, 15 say '       X to exit program and';
           + 'save current data.'
     store 'Z' to choice
     set confirm off
     do while .not. choice  $ ' EX'
      store ' ' to choice
      @ 24, 22 get choice picture '!'
      read
      @ 19, 0 clear
     enddo
     replace date with mdate, island with island
     replace transect with mtransect
     store board to mboard
     store species to mspecies
   enddo
enddo
clear
clear all
set talk on
cancel
```

```
if choice< >'E'
 append blank
endif
@ 0, 14 say mdate
@ 1, 14 say ltrim(str(mboard))
@ 2, 14 say trim(mspecies)
clear gets
set confirm on
@ 23, 15 say 'Press PgDn to jump to menu'
@  9, 15 get mdate
@ 11, 15 get misland    picture '@!'
@ 13, 15 get mtransect  picture '@!'
@ 15, 15 get board      range 1, 60
@  9, 53 get species    picture '@!'
@ 11, 53 get length     range 0, 30
@ 13, 53 get weight     range 0, 75
@ 18, 20 get comment
read
if mtransect=' ' .or. species=' '
 delete
 set bell on
 ? chr(7)
 set bell off
 @ 22, 15 say  'Either the transect or species';
          +' name was blank.'
 @ 23,  5 say  'This record will not been added to';
          +' the data base unless it is edited.'
 wait '                Press any key to';
    +' continue . . . '
 store 'Y' to error
 @ 19, 0 clear
endif
do case
case misland='SB'
 if species< >'XR'
  store 'Y' to error
 endif
case misland='SM'
 if species< >'BP' .and. species< >'GM' .and.;
   species< >'SO'
  store 'Y' to error
 endif
case misland='AI'
 if species< >'BP' .and. species< >'GM' .and.;
   species< >'US'
  store 'Y' to error
 endif
otherwise
 store 'Y' to error
endcase
if error='Y'
 set bell on
 ? chr(7)
 set bell off
```

## HERP.PRG

```
************************************************************
*
*   HERP.prg
*
*   This is a data entry program for salamander and lizard
*   data for Anacapa, Santa Barbara and San Miguel
*   Islands.
*
*   Program was written by:  Gary M. Fellers
*                            Point Reyes National Seashore
*
*                            415-663-8522.
*
*
*   Program last updated:  May 5, 1988
*
************************************************************

clear
clear all
use herp
set bell off
set deleted on
set carry off
set talk off
go bottom
store date to mdate
store board to mboard
store species to mspecies
store space(2) to misland, mtransect
store 'Z' to choice
do while choice < > 'X'
  @  0,  0 say 'Last date'
  @  1,  0 say 'Last board'
  @  2,  0 say 'Last species'

  @  2, 26 to 4, 50 double
  @  6,  5 to 6, 75 double
  @  3, 31 say 'Herp Data Entry'

  @  9,  5 say 'Date           (mm/dd/yy)'
  @ 11,  5 say 'Island       (AI, SB, SM)'
  @ 13,  5 say 'Transect'
  @ 15,  5 say 'Board'
  @  9, 43 say 'Species     (BP, GM, SO, US, XR)'
  @ 11, 43 say 'Length        cm'
  @ 13, 43 say 'Weight        g'
  @ 18, 10 say 'Comment'
  do while choice < > 'X'
  @ 19, 0 clear
  store 'N' to error
```

## MOUSE.PRG

```
************************************************************
*
*    MOUSE.PRG
*
*    This is a data entry program for mouse data for
*      Anacapa, Santa Barbara and San Miguel Islands.
*
*    Program was written by:  Gary M. Fellers
*                             Point Reyes National Seashore
*
*                             415-663-8522.
*
*
*    Program last updated:  June 1, 1988
*
************************************************************


clear
clear all
set bell off
set deleted on
set carry off
set talk off
set confirm on
store space(8) to mfile
@  4, 5 to 24, 74
@  4, 22 clear to 5, 56
@  1, 22 to 5, 56 double
@  3, 27 say "Mouse Data Entry Program"
@ 11, 24 say "Enter name of file to be used."
@ 13, 24 say "  Do not enter an extension."
@ 15, 35 get mfile
read
store trim(mfile)+".dbf" to mfile
if .not. file("&mfile")
  use mouse
  copy stru to &mfile
endif
use &mfile
go bottom
store date to mdate
store tag to mtag
store island to misland
store grid to mgrid
do case
  case x1<>0
    store x1 to mx
    store y1 to my
  case x2<>0
    store x2 to mx
```

```
   store y3 to my
  case x3< >0
   store x3 to mx
   store y3 to my
  otherwise
   store 0 to mx
   store 0 to my
endcase
store 1 to mday
store "Z" to choice
clear
do while choice < > "X"
 @  0,  0 say "Last date"
 @  1,  0 say "Last station   , "
 @  2,  0 say "Last tag"

 @  2, 26 to 4, 51 double
 @  6,  5 to 6, 75 double
 @  3, 31 say "Mouse Data Entry"

 @  8,  5 say "Date            (mm/dd/yy)"
 @ 10,  5 say "Island     (AI, SB, SM)"
 @ 12,  5 say "Grid"
 @ 14,  5 say "Tag"
 @ 16,  5 say "Station  X    Y "
 @ 18,  5 say "Trapping Day    (1, 2, or 3)"
 @  8, 43 say "Age        (J, S, A)"
 @ 10, 43 say "Sex        (M, F)"
 @ 12, 43 say "Repro.     (L, -)"
 @ 14, 43 say "Weight      g"
 @ 16, 40 say "Comment"
 do while choice < > "X"
  @ 20, 0 clear
  store "N" to error
  store "-" to mrepro
  if choice< >"E"
   append blank
  endif
  @ 0, 14 say mdate
  @ 1, 14 say ltrim(str(mx, 2))
  @ 1, 17 say ltrim(str(my, 2))
  @ 2, 14 say mtag
  clear gets
  set confirm on
  @ 22, 15 say "Press PgDn to jump to menu"
  @  8, 13 get mdate
  @ 10, 13 get misland   picture "@!"
  @ 12, 13 get mgrid     picture "@!"
  @ 14, 13 get tag      picture "####"
  @ 16, 16 get mx        picture "99" range 1,10
  @ 16, 22 get my        picture "99" range 1,10
  @ 18, 19 get mday      picture "9"  range 1, 3
  @  8, 51 get age      picture "@!"
  @ 10, 51 get sex      picture "@!"
```

```
  @ 12, 51 get mrepro    picture "@!"
  @ 14, 51 get weight    range 0, 75
  @ 17, 40 get comment
 read
 do case
 case misland="SB"
  if mgrid< >"TC" .and. mgrid< >"TG" .and. mgrid< >"WP"
    store "Y" to error
  endif
 case misland="SM"
  if mgrid< >"PB" .and. mgrid< >"GM" .and. mgrid< >"SM";
     .and. mgrid< >"HP".and. mgrid< >"HE" .and.;
     mgrid< >"AS" .and. mgrid< >"WC"
    store "Y" to error
  endif
 case misland="AI"
  if mgrid< >"EA".and. mgrid< >"MA" .and. mgrid< >"WA"
    store "Y" to error
  endif
 otherwise
  store "Y" to error
 endcase
 if error="Y"
  set bell on
  ? chr(7)
  set bell off
  @ 20, 15 say "The island and grid do not match."
  @ 21, 15 say "Press E  to edit entry."
  @ 22, 15 say "      D  to delete this record and";
           +" continue."
  @ 23, 15 say "      X  to delete this record and";
           +" exit program."
  store "Z" to choice
  set confirm off
  do while .not. choice  $ "EDX"
    store " " to choice
    @ 24, 21 get choice picture "!"
    read
  enddo
  set confirm on
  if choice = "E"
    loop
  else
    delete
    loop
  endif
 endif
 if mgrid="  " .or. tag="    "
  set bell on
  ? chr(7)
  set bell off
  @ 20, 15 say  "Either the grid or tag number was";
           +" blank."
   @ 21, 15 say "Press E  to edit entry."
```

```
 @ 22, 15 say "     D  to delete this record and";
        +" continue."
 @ 23, 15 say "     X  to delete this record and";
        +" exit program."
 store "Z" to choice
 set confirm off
     do while .not. choice  $ "EDX"
      store " " to choice
      @ 24, 21 get choice picture "!"
      read
     enddo
     set confirm on
     if choice = "E"
      loop
     else
      delete
      loop
     endif
    endif
    @ 21, 15 say "Press  RETURN to add more data."
    @ 22, 15 say "      E to edit entry.       "
    @ 23, 15 say "      X to exit program and save";
           +" current data."
    store "Z" to choice
    set confirm off
    do while .not. choice  $ " EX"
     store " " to choice
     @ 24, 22 get choice picture "!"
     read
     @ 20, 0 clear
    enddo
    set confirm on
    if error< >"Y" .and. choice< >"E"
     replace date with mdate, island with misland
     replace grid with mgrid, repro with mrepro
     do case
     case mday=1
      replace x1 with mx
      replace y1 with my
     case mday=2
      replace x2 with mx
      replace y2 with my
     case mday=3
      replace x3 with mx
      replace y3 with my
     endcase
     store grid to mgrid
     store tag to mtag
    else
     delete
    endif
   enddo
enddo
clear
clear all
set talk on
cancel
```

## MOUSE_C.PRG

```
************************************************************
*
*   MOUSE_C.prg
*
*   This is a data conversion program for mouse data for
*     Anacapa, Santa Barbara and San Miguel Islands.
*
*   Program was written by:  Charles Drost and
*                            Gary M. Fellers
*
*                            Point Reyes National Seashore
*
*                            415-663-8522.
*
*
*   Program last updated:  June 1, 1988
*
************************************************************

clear
clear all
set bell off
set deleted on
set carry off
set talk off
set confirm on
@ 4,5 to 24, 74
@ 4, 20 clear to 5, 57
@ 1, 19 to 5, 58 double
@ 3, 24 say "Mouse Data Conversion Program"
erase temp_x.dbf
erase temp_x.ndx
erase temp_xt.dbf
erase temp_xt.sdf
erase temp_xs.dbf
store space(8) to mfile
@ 10, 21 say 'Enter name of file to be converted.'
@ 12, 21 say '  Do not enter an extension.'
@ 14, 35 get mfile
read
@ 10, 10 clear to 14, 60
@ 9, 10 say 'Creating temporary data file. . . '
store trim(mfile) to mfile
store '&mfile'+'.dbf' to cfile
use &cfile
store trim(grid) to mgrid
store date to mdate
copy fields tag, x1, y1, x2, y2, x3, y3 to temp_x
use temp_x
@ 11, 10 say 'Deleting records with no tag number. . . '
delete for val(tag) < 1
```

```
pack
@ 13, 10 say 'Indexing file. . . '
index on tag to temp_x
@ 15, 10 say 'Totalling data. . . '
total on tag to temp_xt
use temp_xt
@ 17, 10 say;
    'Creating ASCII data file for use with CAPTURE. . . '
@ 23,  0 say ''
copy to temp_xt.sdf sdf
use mouse_t
copy stru to temp_xs
store '&mfile'+'.sdf' to mfile
use temp_xs
append blank
replace field with "TITLE=" + "'";
  + "POPULATION ESTIMATE FOR " + mgrid;
  + " GRID, " + dtoc(mdate) + "'"
append blank
replace field with;
 "TASK READ CAPTURES OCCASIONS=3 XY COMPLETE SUMMARY"
append blank
replace field with;
 "DATA='DATA FROM VERTEBRATE MONITORING PROGRAM'"
append blank
replace field with "FORMAT='(A4,3(2F2.0))'"
append blank
replace field with  "READ INPUT DATA"
append from temp_xt.sdf sdf
append blank
replace field with "TASK MODEL SELECTION"
append blank
replace field with;
 "TASK POPULATION ESTIMATE APPROPRIATE JACKNIFE"
delete for field='     '
copy to &mfile sdf
clear
@ 4, 0 say ''
?'              File', mfile, 'successfully created.'
@  3, 14 to 7, 63 double
@ 22,  0 say ''
clear all
erase temp_x.dbf
erase temp_x.ndx
erase temp_xt.dbf
erase temp_xt.sdf
erase temp_xs.dbf
set talk on
```

## FOX.PRG

```
************************************************************
*
*   FOX.PRG
*
*   This is a data entry program for Island Fox data.
*
*   Program was written by:  Gary M. Fellers
*                            Point Reyes National Seashore
*
*                            415-663-8522.
*
*
*   Program last updated:  July 22, 1988
*
************************************************************

clear
clear all
set bell off
set deleted on
set carry off
set talk off
set confirm on
store space(8) to mfile
@  4, 5 to 24, 74
@  4, 22 clear to 5, 56
@  1, 22 to 5, 56 double
@  3, 28 say "Fox Data Entry Program"
@ 11, 26 say "Enter name of file to be used."
@ 13, 26 say "  Do not enter an extension."
@ 15, 35 get mfile
read
store trim(mfile)+".dbf" to mfile
if .not. file("&mfile")
 use fox
 copy stru to &mfile
endif
use &mfile
go bottom
store date to mdate
store tag  to mtag
store grid to mgrid
store trap to mtrap
do case
 case x1<>0
  store x1 to mx
  store y1 to my
 case x2<>0
  store x2 to mx
  store y3 to my
 case x3<>0
```

```
   store x3 to mx
   store y3 to my
  case x4< >0
   store x4 to mx
   store y4 to my
  case x5< >0
   store x5 to mx
   store y5 to my
  case x6< >0
   store x6 to mx
   store y6 to my
  case x7< >0
   store x7 to mx
   store y7 to my
  case x8< >0
   store x8 to mx
   store y8 to my
  otherwise
   store 0 to mx
   store 0 to my
endcase
store 1 to mday
store "Z" to choice
clear
do while choice < > "X"
  @  0,  0 say "Last date"
  @  1,  0 say "Last number"
  @  2,  0 say "Last station"

  @  2, 26 to 4, 52 double
  @  6,  5 to 6, 75 double
  @  3, 32 say "Fox Data Entry"


  @  8,  5 say "Date            (mm/dd/yy)"
  @ 10,  5 say "Grid"
  @ 12,  5 say "Fox #"
  @ 14,  5 say "Trap"
  @ 16,  5 say "Trapping Day    (1 - 8)"
  @ 18,  5 say "Weight      Kg"
  @  8, 43 say "Age         Sex   (M, F)"
  @ 10, 43 say "Injury"
  @ 12, 43 say "Parasite"
  @ 14, 43 say "Shedding"
  @ 16, 40 say "Comment"
  do while choice < > "X"
    @ 20, 0 clear
    store "N" to error
    if choice< >"E"
      append blank
    endif
    @ 0, 14 say mdate
    @ 1, 14 say mtag
    @ 2, 14 say ltrim(str(mtrap, 3))+ "   "
```

```
clear gets
set confirm on
@ 22, 15 say "Press PgDn to jump to menu"
@  8, 13 get mdate
@ 10, 13 get mgrid    picture "@!"
@ 12, 13 get tag      picture "####"
@ 14, 13 get trap     picture "999" range 1, 125
@ 16, 19 get mday     picture "9"   range 1, 8
@ 18, 13 get weight   range 0, 3
@  8, 48 get age      picture "@!"
@  8, 62 get sex      picture "@!"
@ 10, 52 get injury   picture "@!"
@ 12, 52 get shed     picture "@!"
@ 14, 52 get parasite picture "@!"
@ 17, 40 get comment
read
if mgrid< >"GM" .and. mgrid< >"HP" .and. mgrid< >"PB";
  .and. mgrid< >"SM" .and. mgrid< >"WC"
 store "Y" to error
endif
if error="Y"
 set bell on
 ? chr(7)
 set bell off
 @ 20, 15 say "Incorrect grid abbreviation."
 @ 21, 15 say "Press E  to edit entry."
 @ 22, 15 say "      D  to delete this record and";
          +" continue."
 @ 23, 15 say "      X  to delete this record and";
          +" exit program."
 store "Z" to choice
 set confirm off
 do while .not. choice  $ "EDX"
  store " " to choice
  @ 24, 21 get choice picture "!"
  read
 enddo
 set confirm on
 if choice = "E"
  loop
 else
  delete
  loop
 endif
endif
if mgrid="  " .or. tag="    "
 set bell on
 ? chr(7)
 set bell off
 @ 20, 15 say  "Either the grid or tag number";
           +" was blank."
 @ 21, 15 say "Press E  to edit entry."
 @ 22, 15 say "      D  to delete this record";
          +" and continue."
```

```
 @ 23, 15 say "     X  to delete this record and";
         +" exit program."
 store "Z" to choice
 set confirm off
 do while .not. choice  $ "EDX"
  store " " to choice
   @ 24, 21 get choice picture "!"
   read
 enddo
 set confirm on
 if choice = "E"
   loop
 else
   delete
   loop
 endif
endif
@ 21, 15 say "Press  RETURN to add more data."
@ 22, 15 say "       E to edit entry.       "
@ 23, 15 say "       X to exit program and save";
         +" current data."
store "Z" to choice
set confirm off
do while .not. choice  $ " EX"
 store " " to choice
 @ 24, 22 get choice picture "!"
 read
 @ 20, 0 clear
enddo
set confirm on
if error< >"Y" .and. choice< >"E"
 replace date with mdate, grid with mgrid
 store trap to mtrap
 do while mtrap>25
   mtrap= mtrap-25
 enddo
 do case
 case mtrap< =5
   store 1 to mx
 case mtrap>5  .and. mtrap< =10
   store 2 to mx
 case mtrap>10 .and. mtrap< =15
   store 3 to mx
 case mtrap>15 .and. mtrap< =20
   store 4 to mx
 case mtrap>20 .and. mtrap< =25
   store 5 to mx
 endcase
 store mod(mtrap, 10) to my
 if my>5
   store my-5 to my
 endif
       do case
       case mday=1
```

```
          replace x1 with mx
          replace y1 with my
        case mday=2
          replace x2 with mx
          replace y2 with my
        case mday=3
          replace x3 with mx
          replace y3 with my
        case mday=4
        replace x4 with mx
        replace y4 with my
      case mday=5
        replace x5 with mx
        replace y5 with my
      case mday=6
        replace x6 with mx
        replace y6 with my
      case mday=7
        replace x7 with mx
        replace y7 with my
      case mday=8
        replace x8 with mx
        replace y8 with my
      endcase
      store grid to mgrid
      store tag to mtag
      store trap to mtrap
    else
     delete
    endif
  enddo
enddo
clear
clear all
set talk on
cancel
```

## FOX_C.PRG

```
************************************************************
*
*   FOX_C.PRG
*
*   This is a data conversion program for fox data for
*   San Miguel Island.
*
*   Program was written by:  Charles Drost and
*                            Gary M. Fellers
*
*                            Point Reyes National Seashore
*
*                            415-663-8522.
*
*
*   Program last updated:  July 22, 1988
*
************************************************************

clear
clear all
set bell off
set deleted on
set carry off
set talk off
set confirm on
@ 4,5 to 24, 74
@ 4, 20 clear to 5, 57
@ 1, 19 to 5, 58 double
@ 3, 25 say "Fox Data Conversion Program"
erase temp_x.dbf
erase temp_x.ndx
erase temp_xt.dbf
erase temp_xt.sdf
erase temp_xs.dbf
store space(8) to mfile
@ 10, 21 say 'Enter name of file to be converted.'
@ 12, 21 say '  Do not enter an extension.'
@ 14, 35 get mfile
read
@ 10, 10 clear to 14, 60
@ 9, 10 say 'Creating temporary data file. . . '
store trim(mfile) to mfile
store '&mfile'+'.dbf' to cfile
use &cfile
store trim(grid) to mgrid
store date to mdate
copy fields tag, x1, y1, x2, y2, x3, y3 to temp_x
use temp_x
@ 11, 10 say 'Deleting records with no fox number. . . '
delete for val(tag)<1
```

**APPENDIX G- 6. Continued**

```
pack
@ 13, 10 say 'Indexing file. . . '
index on tag to temp_x
@ 15, 10 say 'Totalling data. . . '
total on tag to temp_xt
use temp_xt
@ 17, 10 say 'Creating ASCII data file for use with';
   +' CAPTURE. . . '
@ 23,  0 say ''
copy to temp_xt.sdf sdf
use fox_t
copy stru to temp_xs
store '&mfile'+'.sdf' to mfile
use temp_xs
append blank
replace field with "TITLE=" + "'";
   + "POPULATION ESTIMATE FOR " + mgrid + " GRID, ";
   + dtoc(mdate) + "'"
append blank
replace field with;
   "TASK READ CAPTURES OCCASIONS=8 XY COMPLETE SUMMARY"
append blank
replace field with;
   "DATA='DATA FROM VERTEBRATE MONITORING PROGRAM'"
append blank
replace field with "FORMAT='(A4,8(2F1.0))'"
append blank
replace field with  "READ INPUT DATA"
append from temp_xt.sdf sdf
append blank
replace field with "TASK MODEL SELECTION"
append blank
replace field with;
   "TASK POPULATION ESTIMATE APPROPRIATE JACKNIFE"
delete for field='     '
copy to &mfile sdf
clear
@ 4, 0 say ''
?'              File', mfile, 'successfully created.'
@  3, 14 to 7, 63 double
@ 22,  0 say ''
clear all
erase temp_x.dbf
erase temp_x.ndx
erase temp_xt.dbf
erase temp_xt.sdf
erase temp_xs.dbf
set talk on
```

# CALC.BAT

```
copy %1.sdf captin
assign b=c
capture
assign
copy captlp %1.out
```

## CAPTURE Input Files

Sample Mouse Input File

```
TITLE='Population Estimate for Green Mountain, 3/85'
TASK READ CAPTURES OCCASIONS=3 XY COMPLETE SUMMARY
DATA='Mouse Data'
FORMAT='(A4,3(2F2.0))'
READ INPUT DATA
1017030200000000
1018000005010000
1021000010020000
1020000003020402
1022000003040000
1019000005040000
1023000000000102
1024000000000502
1025000000000104
1027000001100000
1026000004050000
1028000000001010
TASK CLOSURE TEST
TASK MODEL SELECTION
```

Sample Fox Input File

```
TITLE='Population Estimate for San Miguel Hill, 5/85'
TASK READ CAPTURES OCCASIONS=8 XY COMPLETE SUMMARY
DATA='Fox Data'
FORMAT='(A4,8(2F1.0))'
READ INPUT DATA
00321200001300001200
00220021000000210000
11110022000023002200
00200012120000000000
00270014001400000014
00190024002324000000
10440000520000515200
10450000220021000000
10460000140000130000
10480000000000100012
10500000000000090000
10550000001100000000
TASK CLOSURE TEST
TASK MODEL SELECTION
```

## Format of the CAPTURE input file

In case the input file needs to be customized, the following discussion explains each line of the file. Note that the input file must be pure ASCII (=unformatted).

The TITLE statement should be edited to reflect the calculation being conducted.

The TASK statement indicates that there were three days of trapping for mice and eight days for foxes. This line would need to be edited only if the trapping sequence did not last the standard number of days. Hence the number 3 for mice or the number 8 for foxes would need to be changed to the appropriate number of days.

The DATA statement should be edited to reflect the calculation being conducted.

The FORMAT statement for the mouse data indicates that the animal number occupies the first four columns and that there are three days of data. The number 3 in the FORMAT line would need to be changed to another number if there were a different number of days. Similarly, the number 8 in the FORMAT line of the fox sample would need to be changed if there were not eight days of trapping. The "2F2.0" indicates that there are two columns of two digit numbers (1-10) for each day. Note that the fox format "2F1.0" uses only one digit numbers (1-5).

The data lines following the READ INPUT DATA statement consist entirely of numbers. For the mouse sample, each line represents the capture history of one mouse for that trapping session. The first four digits are the tag number of the mouse and the following digits are the x,y coordinates for the trap where the mouse was captured each day. Both the x and y numbers are two digit and thus a trap is represented by four digits (=four columns of data). Days when a mouse was not caught are entered as four

zeros. The number of data lines equals the number of individuals caught. Hence, if only four mice were caught, there would be four lines of data. For example, the first data line indicates that mouse 1017 was captured in trap 3,2 on the first day and was not captured on any other day. The second data line indicates that mouse 1018 was caught in trap 5,1 on day two, but was not captured on the first or last day. The fox example differs in that x and y numbers are only single digits for a total of two digits for each trap site.

The final TASK statements specify how the program should process data. These lines never change.

## Data Anomalies

Unfortunately, field work does not always go as planned. There are several real or apparent problems that might arise during the course of trapping. Several of the most likely are listed below with the recommended solution.

1. More than one animal in a trap. This is not a problem. Simply record each animal in the usual fashion. None of the statistics depend on the number of animals in a trap.
2. A released animal is immediately recaptured elsewhere on the grid. This is not a problem. The second capture should be ignored and the animal immediately released with a slight admonishment.
3. An animal escapes before it is tagged or an existing tag is not read. Escapees reduce the number of animals available for data analysis and thus reduce the accuracy of the population estimate. Hence care should be taken to avoid letting animals escape. This is the reason that the tagging and recording of tag data must be done first. The solution to the problem is to not record the animal as a capture, e.g. animals without tag numbers are not entered in the data set, but should be recorded on the field form.
4. An animal is dead in the trap on the last day of trapping. Statistically, this is not a problem. Record the tag number or assign a new number if it is not a recapture. The data analysis can proceed as usual. The reason for the death should be considered so that trap death can be reduced in future trapping.
5. An animal dies in a trap prior to the last day of trapping. Treatment of the data depends on how many animals die. If more than 20% of the total captures were dead, CAPTURE cannot be used. There are other models based on removal techniques which might be appropriate, but discussion of these is

beyond the scope of this handbook.

If there is less than 5% loss, delete all captures of those animals from the data set and run the analysis as usual. The resulting population estimate is for the animals remaining in the population. To calculate the number at the start of trapping add the number of dead animals to the final estimate of population size. If a population density is being calculated, multiply it by (1 + proportion of dead animals).

If there is 5-20% loss, it would be best to use a removal model to calculate populations size, but CAPTURE can be used if the remaining data are sufficient to meet the statistical considerations discussed below. The generalized removal model can be specified by replacing the last line "TASK POPULATION ESTIMATE APPROPRIATE JACKNIFE" with the line "TASK POPULATION ESTIMATE REMOVAL."

## Interpreting the CAPTURE printout

The output file (*.OUT) will need to be printed on a wide-carriage printer. The first few lines summarize the input statements. These should be examined for accuracy. The maximum x and y grid coordinates refer to the maximum numbers encountered in the data set analyzed, not the true size of the grid. These numbers should never be greater than 10 for mice and 5 for foxes.

The next section of the program describes the various models which might be selected as being most appropriate. There is also a discussion of notation which might be helpful in reading the rest of the printout.

The first page of data summarizes the animals captured and the distance moved. As noted on the printout, distances are in units of "trap intervals." For the mice, actual distance can be calculated by multiplying the listed distance by 7 m. For fox data, this distance should be multiplied by 0.2 mi (or 0.32 km). This part of the printout should be examined mostly to see if there are any obvious errors in the data entry. Otherwise it provides additional data the park will not need to consider further.

The section which lists each model can generally be ignored unless someone has a strong interest in statistics. The critical part is the last few lines where the population estimate, standard error and estimated probability of capture (p-hat) are given.

APPENDIX H - 2.

## Statistical interpretation

A good population estimate is characterized by a high estimated probability of capture (p-hat) and a low coefficient of variation. The coefficient of variation is not shown on the printout, but is easily calculated as:

(standard error/population estimate) x 100

If the coefficient of variation is less than 20%, the estimate will have a small confidence interval. In general, population estimates with coefficients of variation greater than 20% will result in population estimates which are not sufficiently accurate to be of much use.

The accuracy of the calculated population size increases as both population size and probability of capture increase. When the estimated population is $< 100$, capture probabilities (p-hat) should be at least 0.30. As the estimated population size reaches 200, capture probabilities can be as low as 0.20 and still result in an accurate estimate.